**DFO Atlantic Fisheries
Proceedings 97/1**

Meeting 5
December 18, 1996
Regional Advisory Process (RAP)
Habitat Subcommittee:

Middle Shoal Channel Environmental Effects Monitoring Program

H.B. Nicholls (Chairperson and Rapporteur)

Marine Environmental Sciences Division
Science Branch
Maritimes Region
Fisheries and Oceans Canada
Bedford Institute of Oceanography
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January 1997

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PREFACE

The "Middle Shoal Channel Improvement Program" is a channel dredging project in the southern Sydney Bight area of Cape Breton Island, Nova Scotia. Undertaken by the Little Narrows Gypsum Company Limited for the purposes of increasing channel depth and realignment, the proponent claims that the end result will enable bulk carriers transporting gypsum from the company's mine at Little Narrows to foreign and domestic markets to be more fully loaded, and hence to operate more cost effectively. The authorization for the project included the requirement for a monitoring program to be undertaken to "...verify that permit conditions are met and that assumptions made during the review process were correct and sufficient to protect the environment." Dredging got underway on August 20, 1996. It was suspended on October 24, 1996 by a Federal Court order after the Union of Nova Scotia Indians requested a judicial review of the Canadian Environmental Assessment Act (CEAA) review of the project. The project was approximately ninety percent complete at this stage. Monitoring was undertaken throughout the dredging operation (and also before and after) for varying periods according to the particular component of the monitoring program. The peer review of the monitoring program outlined in these proceedings was conducted through the Department of Fisheries and Oceans' Regional Advisory Process (RAP).

1. INTRODUCTION[1]

The Chairperson welcomed participants to the session and outlined arrangements, etc. He noted that while two days had been allowed for the meeting, the situation would be reviewed at the end of the first day in order to ascertain if the second day was necessary; another possibility was to continue into the evening of the first day. Approximately 40 persons were present -- a list of invitees and participants is provided in Appendix 1.

2. APPROVAL OF AGENDA

The tentative agenda (refer to Appendix 2) provided to invitees in advance of the meeting was approved subject to some rearrangement of the order in which the items were considered.

3. BACKGROUND

The Chairperson provided a brief outline of the "Middle Shoal Channel Improvement Program," noting that a fuller description of this dredging project would be provided by the proponent under Agenda Item #5. He noted that the authorization for the project included the requirement for a monitoring program to be undertaken to "...verify that permit conditions are met and that assumptions made during the review process were correct and sufficient to protect the environment." The resulting Environmental Management Plan (Little Narrows Gypsum Company, 1996) prepared by the proponent, in consultation with DFO and Environment Canada, includes an "Environmental Effects Monitoring and Compliance" program.

Dredging got underway on August 20, 1996 with the monitoring program in place. Dredging was suspended on October 24, 1996 by a Federal Court order after the Union of Nova Scotia Indians requested a judicial review of the Canadian Environment Assessment Act (CEAA) review of the project. The project was approximately ninety percent complete at this stage.

The current session comprises part of a review by scientific experts of the monitoring program. The Chairperson explained that this review was being undertaken on account of:

- the requirement of the monitoring program to "...verify that permit conditions are met and that assumptions made during the review process were correct and sufficient to protect the environment";
- a commitment given by the Regional Directors-General of DFO and Environment Canada that scientists would review the results of the monitoring program; and
- the October 23, 1996 Federal Court decision pertaining to the dredging project.

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[1] During this agenda item representatives of several fishermen's organizations raised concerns about the lack of consultation by both the proponents and DFO/Environment Canada prior to and during the early stages of the Middle Shoal Channel Improvement Program. Since this matter did not strictly fall within the objectives of the current review, arrangements were made for these representatives to meet with Brian Thompson of DFO and Adrian MacDonald of Environment Canada during the lunch break in order to pursue this matter.

By way of background on the scientific review process that is being applied to the monitoring program, it was noted that the same process, the DFO Regional Advisory Process (RAP) (previously CAFSAC [Canadian Atlantic Fisheries Scientific Advisory Committee] process), has been applied to fish stock assessment issues for many years. Recently it was decided that the same process should be applied to significant habitat and ecosystem impact issues, and the Middle Shoal Channel Environmental Effects Monitoring Program is one of the first such issues to be addressed. The process is one that is open and transparent and follows scientific convention, i.e., conclusions and theories must be supported by scientific reasoning, backed-up by reliable data, and reached through scientific methods. The process also takes full account of traditional knowledge pertaining to the issue. The outcome need not be one of absolute unanimity but rather an effort towards reaching consensus, with areas of any disagreement being part of the resulting report.

4. MEETING OBJECTIVES

The meeting was advised that the primary objective of the review is to provide a response to the following Statement-of-Issue:

> *Does the monitoring program developed and undertaken by the proponent, along with scientific expertise derived from other such projects and general scientific theory, allow us to discern the impact of the 1996 dredging operation in Middle Shoal Channel on the movement of fish in an through the channel, and on fish habitat?*

The Chairperson stated that this response will be documented in the form of a Habitat Status Report, to be produced in accordance with the schedule that he tabled (refer to Appendix 3, which also includes a subsequent revised version. It will be noted from the schedule that there is to be a subsequent RAP that will comprise a reconsideration of the July 1996 Middle Shoal Channel Improvement Program's environmental screening decision in light of the most recent data and information, including the results of this RAP.) Prior to the release of the Habitat Status Report, a Proceedings document will be issued that outlines the deliberations of the meeting and includes copies of all items tabled or presented.

5. OVERVIEW AND STATUS OF MIDDLE SHOAL CHANNEL PROJECT

John Fitzgerald, Program Manager, Middle Shoal Project, USG Canadian Mining Corp., presented a brief overview and status report on the Middle Shoal dredging project (copies of his transparencies are provided in Appendix 4.) Several questions of clarification were asked about the project, and several fishermen's organizations raised concerns about the degree of consultation with their groups.

6. ROLE OF THE MONITORING COMMITTEE AND INVOLVEMENT OF FISHERMEN

Kevin Squires, a Big Bras d'Or fisherman and chairperson of the Middle Shoal Project Environmental Monitoring Committee, spoke to this item. He prefaced his remarks by stating that this aspect of the monitoring program provides a good example of how a local community can react to and work with the scientific community. He first addressed the role of the monitoring committee. He noted that the Environmental Management Plan, with its "Environmental Effects Monitoring and Compliance" program called for the establishment of such a committee. Mr. Squires outlined the membership of the Monitoring Committee (refer to Appendix 5[a]), indicating that it met bi-weekly during the period August through October, 1996, and noted that the committee did not "dissect" the detailed results but maintained a watching brief to ensure that "things were being done," i.e., it served more of a "community function." K. Squires then reviewed the role of fishermen, noting that they were at the project site every day keeping an eye on things. Details of the fishermen's involvement is provided in Appendix 5(b), which comprises a copy of the notes Mr. Squires prepared for his presentation. Also pertaining to this item (Appendix 5[c]) is a summation of the main points Mr. Squires made in his presentation as compiled by John Amirault, Environmental Studies Coordinator, Middle Shoal Channel Project, Little Narrows Gypsum Company. Kevin Squires ended his presentation by suggesting improvements that should be made next time:

- allow more lead time to prepare for the committee's activities during the actual monitoring period;
- hire an independent consultant to assist the committee, e.g. in interpreting the data collected;
- maintain better communication with DFO and Environment Canada; and
- maintain better communication with members of fisher organizations and community groups to keep them better informed.

During the question period following Mr. Squire's presentation, David Scarratt, David Scarratt and Associates, raised the issue of the future role of the monitoring committee, in particular with respect to ascertaining the long-term effects of the dredging operation. K. Squires stated that the committee had recently "adjourned" its activities for this year but planned to recommence in the summer of 1997 when additional oceanographic and habitat investigations will have been completed. Mr. Scarratt raised the matter of the monitoring of fishing operations to ascertain if there are any long-term effects on catch, etc. Dan Christmas, Union of Nova Scotia Indians, stated that the committee should have had more time and support in order to fulfill its role. Other questions were raised about the make-up of the monitoring committee.

7. REPORTS ON MONITORING[2]

7.1 INTRODUCTION TO THE MONITORING PROGRAM

John Amirault, Environmental Studies Coordinator, Middle Shoal Project, Little Narrows Gypsum Company, provided a brief introduction and background to the monitoring program. In particular he traced the development of the project with respect to technical investigations, cost/benefit studies, the environmental assessment process and regulatory and financial approvals and implementation. Copies of his transparencies are provided in Appendix 6.

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[2] Note that copies of a draft "Environmental Monitoring Report on the Middle Shoal Channel Project" (Little Narrows Gypsum Company, 1996) were provided to senior representatives of DFO and Environment Canada attending the RAP meeting on December 18. These were provided outside of the actual meeting, and the document was not formally tabled by the proponent. However, many of the items presented by the proponent at the meeting in the form of overheads, etc. are also included in this document.

7.2 REPORTS ON PHYSICAL OCEANOGRAPHY AND SEDIMENT MONITORING

7.2.1 Physical Oceanography

Dr. Jim Warner, Martec Ltd., made this presentation. Copies of his transparencies are provided in Appendix 7(a). He outlined the objectives of the program:

1. Collect oceanographic data prior to the commencement of dredging operations for use in identifying/tracking sediment plumes and determining water properties.
2. Verify previous hydrodynamic current modelling scenarios and predict hydrodynamic conditions following channel alterations.
3. Determine the exchange of water into and out of the lake for pre-dredge and post-dredge conditions.
4. Identify regions of stratification and mixing that may influence hydrodynamic modelling of sediment dispersion during the dredging activities.

The following monitoring was undertaken using an acoustical Doppler current profiler (ADCP) during the period July 25-September 7, 1996: nine transect locations (refer to Appendix 7(a) for details), which extend shoreline to shoreline from the Big Bras d'Or Wharf at the Bras d'Or Lake end of the Great Bras d'Or channel to Gooseberry Point at the Sidney Bight end of the channel, were used as baseline transect positions for a comparative analysis during various stages of the tide; the total discharge into and out of the Great Bras d'Or channel was monitored at one transect position at four different stages of the lunar cycle for a period of at least 12 hours each; and data was collected on current magnitude and direction at Dump Sites 'A' and 'B', and surrounding the dredging operation. A tide gauge with thermistor sensor was deployed at Duffus Point (at the lake end of the channel) from July 28 to August 31, 1996 to obtain a time series of water elevation and bottom water temperature. Finally, a conductivity/temperature/depth (CTD) profiler equipped with an optical backscutter sensor was used during the period July 25 to October 15, 1996 to identify the areas of stratification and general water characteristics at the entrance to Great Bras d'Or at Dump Sites A&B, across the outer entrance and surrounding the dredging operation. A summary of the data collected is provided in Appendix 7(a). In concluding his presentation, Dr. Warner noted that as a result of this work it has been possible to quantify oceanographic conditions in the study area before and after dredging commenced; he further noted that the results indicate very small effects on the oceanographic conditions of the region including effects on salinity within the lake. During the discussion of this component of the monitoring program, Trevor Kenchington, Gadus Associates, sought clarification on whether any measurements had been made after the cessation of dredging so that a before-and-after comparison could be made. In response it was confirmed that no post-dredging observations had been made, although there are plans for another physical oceanographic program during the summer of 1997. With reference to the proponent's model studies of before-and-after conditions, G. Bugden, DFO, asked if it was appropriate to apply a 2-D model in this area at this time in view of expected vertical stratification. The contractor stated that little vertical shear was present in the current, but presented no data to support this contention. G. Bugden also questioned if a model driven only by the tides was appropriate to this situation in view of the large meteorologically-forced flows observed both in historical data and the ADCP transect data presented. In response, the contractor suggested that it would be possible to force the model using the tide gauge data, which should include the barometric pressure forcing, but that this had not been done. A current meter deployed in the channel, which would have determined the dominant characteristics of the flow during the dredging and settled some of the questions concerning the model validity, unfortunately malfunctioned.

7.2.2 Sediment Dispersion (Turbidity)

Dr. Warner also presented the results of this program. Copies of his transparencies are provided in Appendix 7(b). He outlined the objectives of the program:

1. Minimize potential environmental impacts by ensuring that the sediment concentration levels surrounding the dredges and dump sites are within compliance levels.

2. Assess the turbidity produced by dredging activities in relation to the natural turbidity generated by the flow conditions (tidal area, density flows) and storm related events.

3. Ensure that the dredging turbidity levels entering the lake are less than 10 mg/L above background and within the natural turbidity variability occurring during fair weather conditions.

Dr. Warner reported that measurements of turbidity levels throughout the outer entrance to the Great Bras d'Or were carried out before, during, and after the dredging activities on Middle Shoal. These measurements involved the use of four optical backscatter sensors (OBS) and water bottle sampling techniques. Overall the program utilized bottom mounted instruments, surface mounted instruments, and profile stations (refer to Appendix 7(b) for locations and results.) Among the main conclusions of this program, Dr. Warner noted the following:

- natural turbidity levels measured throughout the entrance to the Great Bras d'Or entrance showed considerable variability;

- dredging turbidity levels were well below compliance levels (refer to Appendix [b]) throughout the dredging and dumping operations; maximum suspended sediment concentrations measured 100 to 200 m away from the dredges were less than 30 mg/L; mean concentrations at these distances were 1 to 4 mg/L above background;

- total quantity of sediment dispersed from one dredge working at the southern end of the channel for a large tide and flood flow is estimated to be approximately 3 to 4 m^3.

- the large amount of coarse dredge material (cobbles, gravel and sand) excavated and the large volumes of water available for dilution were the main factors that contributed to low suspended sediment concentrations.

At this stage in the proceedings the Chairperson tabled a December 12, 1996 memorandum pertaining to sediment dispersion from T.G. Milligan of DFO who was unable to be present at this session (refer to Appendix 7[c]). On the basis of the documents provided to him, Tim Milligan concludes that "Considering the concentrations of SPM indicated by the OBS surveys, I think it unlikely that the concentrations of fine particles in the benthic boundary layer will exceed natural levels."

7.3 REPORTS ON FISHERIES MONITORING PROGRAM

Norval Collins, CEF Consultants Ltd., presented the results of this program assisted by several co-workers. He noted that the fisheries monitoring program was designed to determine the accuracy of impact predictions associated with particular project activities. To accomplish this, the monitoring program aimed to answer specific questions, primarily whether a hypothesis related to a particular impact scenario was true or false. Monitoring used environmental components that provided measurable responses and that were viewed as important to various stakeholder groups.

Key issues associated with the project that were considered for biological monitoring included:

- fish migration or changes in fish behaviour resulting from suspended sediment plumes, light, or noise from project activities;
- changes in fish habitat quality, either from deposition of sediment carried away from dredging or disposal operations, or related to recolonization of a new bottom surface in the dredge or disposal areas; and
- direct mortality of commercially important species if present in dredging or disposal areas during operations.

Mr. Collins' presentation was subdivided by program component as follows:

- **fish migration monitoring** using fixed 'fish finder' transects run on a regular (generally daily) basis;
- **fish behaviour monitoring** using a forward-looking fish finder to observe schools, a fish tracking system to help locate schools, and various methods used for species identification;
- **work area monitoring** using lobster traps and underwater video to determine abundance of important species, such as lobster;
- **habitat station monitoring** using selected areas of fish habitat important to local fishers; such areas were permanently marked to allow for repeated visits to identify any gross changes in habitat through reappraisal; and
- **measurement of underwater noise levels** during a period of peak dredging activity.

Copies of the transparencies presented are provided in Appendix 8(a). These outline the objectives, results and conclusions for each component. Subsequently the following co-workers presented further details on specific components:

- S. Martin - fish migration surveys, calibration of fish finders (Appendix 8[b]).
- L. Imlay - fish migration surveys, transects and data (Appendix 8[c]).
- M. Biagi - fish behaviour monitoring (Appendix 8[d]).

A synopsis of the main points made during the discussion of the presentations is provided below by program component.

7.3.1 Fish migration surveys

Three transects across the entrance to the Great Bras d'Or were run on a regular basis, using sounders (fish finders) on board fishing vessels. The transects were located at Table Rock, Freddy's Cabin and Auld's Cove (for details of locations refer to Appendix 8[c]). The objective was to estimate the number of fish moving in and out of the channel in order to ascertain if there were any changes in patterns as a result of project activities. With respect to the species monitored, ground truthing showed that mackerel were present at all transects while herring were only observed at the inner transect (Aulds Cove) towards the end of the project.

Key issues raised in the discussion/question period:

- the project did not really measure fish migration in and out of the channel, only activity on a given transect line (D. Scarratt). In response to this comment, Norval Collins stated that it was never the intent that the results of this particular component should be interpreted in isolation of other components; he agreed that the monitoring in effect represented a "vertical looking down" at specific transects;

- vessel movement may have influenced fish activity (T. Lambert);

- it was stated that the effective start date of the measurements was one day before the commencement of dredging, but that monitoring continued after dredging was terminated; therefore, it is not possible to make a "before/after" comparison (T. Kenchington);

- a local fisher observed that mackerel catches were lower after the dredging took place compared with periods (years) before; the need for a detailed analysis of commercial mackerel catches was noted.

7.3.2 Fish behaviour monitoring

Fish behaviour monitoring involved ad hoc observation of fish (mackerel) schools in relation to environmental conditions and dredging activity. Individual fish were tagged with a surface marker (styrofoam catamaran) and the movement of the associated school recorded for periods of 10 to 15 hours. A total of 24 schools were tracked in various areas of the Great Bras d'Or channel (for details of locations refer to Appendix 8[d]).

Key issues raised in the question/discussion period:

- the study assumes that after a fish is tagged it returns to its original school but it was suggested that it may return to a different school; this possibly could have been checked by tagging more than one fish from a single school but this was impractical with the tagging method employed and so it was not done;

- with respect to "before-and-after" comparisons, an attempt was made to start monitoring prior to the commencement of the dredging operation to obtain baseline data, but the complexity of the program required a longer than expected learning period, so the results are not considered reliable until about the time dredging commenced; this means that before-and-after comparisons cannot be made (the value of such comparisons based on only one year's observations was questioned by the proponent's investigator);

- in response to a specific question on evidence of the break-up of mackerel schools in the vicinity of the dredge, it was stated that this was not possible to ascertain.

7.3.3 Work area monitoring

Monitoring was conducted to establish the levels of commercial species, i.e., lobster and crab, in the habitat creation areas, Site A and Site B (for details of locations refer to Appendix 8[a], Fish Habitat Stations), using lobster traps and ROV surveys. Also in the ROV surveys the abundance of juvenile cod was assessed. Considerable information on lobster and rock crab was collected. Juvenile cod were not found in significant numbers.

J. Trembley, DFO, asked if monitoring was undertaken at Site B throughout the dumping period. In response the proponent stated that monitoring was not undertaken at Site B, but it was at Site A.

Note that a previous DFO Regional Advisory Process addressed the issue of lobster and juvenile cod distributions at Site A (Pringle, J.D. 1996; Anon. 1996).

7.3.4 Fish habitat stations

Four habitat sites and one control site were established to provide indicators of changes as a result of the dredging operations (for details of locations refer to Appendix 8[a], Fish Habitat Stations). An assessment of the initial condition of these sites was based on underwater video and analysis of triplicate benthic samples. The sites were not reoccupied at the cessation of dredging but could be in the future in order to evaluate longer-term impacts on habitat quality.

No significant issues were raised during the discussion of this program component.

7.3.5 Underwater sound

Noise measurements were taken at four different sites 70 to 1730 m from the dredging activity on one day (September 30) when all four dredges were operating (for details of locations refer to Appendix 8[a], Underwater Sound Measurements). Noise levels of 60dB above ambient ("moderately noisy") were measured at one site (site #4), the highest of the measurements. To promote a fish response, the noise must be 20-30 dB above ambient. Measurements indicate noise levels associated with this project drop to 20dB above ambient about 110 m from the noise centre. According to the investigator, beyond this point noise should not significantly disturb most fish, including herring, which is a relatively sensitive species.

In response to a question by R. Alexander, DFO, on how the "moderately noisy" level of 60dB compares with other sources, N. Collins stated that it was less than the noise associated with a major storm event, and also (probably) less noisy than the gypsum boats.

In summarizing the fisheries monitoring program, Norval Collins stated that the overall program had been designed so that it could be reviewed and adjusted on an ongoing basis while it was underway in order to identify and respond to environmental concerns as these emerged. In his view, the results of the monitoring indicated that the dredging operation had not had "substantial effects" on the aquatic environment.

8. DISCUSSION AND REVIEW OF MONITORING PROGRAM RESULTS WITH RESPECT TO STATEMENT-OF-ISSUE

Among items considered during the discussion period were the following:

(a) Fish avoidance of, and attraction to, dredge area

It was noted several times during the meeting that smelt were observed in large numbers around the operating dredges. Possibly these were attracted to the disturbed sea bed in order to scavenge. The observance of mackerel near to the dredge area, e.g., refer to fish behaviour monitoring (Appendix 8[d]), may in turn have been due to the fact that they were attracted by the large numbers of smelt.

(b) Fish migration through Great Bras d'Or

T. Kenchington, Gadus Associates, noted that this topic had been considered at the July 1996 meeting between DFO scientists and representatives of the Union of Nova Scotia Indians (UNSI.) With respect to mackerel, the conclusions of the July discussions are in general agreement with the results of the fisheries monitoring program presented at this meeting, i.e., that during the late summer and early fall young mackerel move down the Great Bras d'Or channel from the lakes to the sea. Dr. Kenchington noted that these fish are migrating with the tide to overwinter elsewhere and "couldn't avoid the dredges if they wanted to."

Dr. Kenchington stated that in his opinion mackerel migration was not the key issue, suggesting that the migration of other species coincident with the dredging operation was of greater concern, e.g., herring, salmon, cod and gaspereau. With respect to herring he raised the possibility that herring may be attempting to migrate into the lakes in the late summer/early fall. With respect to the migration of herring, Bob Crawford, N.S. Department of Fisheries, referred to a herring tagging study by DFO in the early 1980s. The results of this investigation (Simon and Stobo, 1983) suggest that the pattern of herring migration is similar to that of mackerel since tagged fish were retrieved in the Great Bras d'Or Lake in April and in Sydney Bight in the following fall/winter.

(c) Impacts of underwater sound from the dredging operation

D. Scarratt, David Scarratt & Associates, referred to the impacts of sound on herring. He referred specifically to work in the Bay of Fundy in the 1970s involving a drilling rig. The results of this investigation indicated that on a calm day herring could detect the sound from the rig some 80 km away, but on a stormy day this dropped to less than 1 km. It was not the absolute level of sound that was critical but the change in level.

(d) Sediment dispersion

With respect to the dispersion of sediments from the dump sites and the dredge site, Jim Rideout, Point Aconi Fishermen's Association, asked if current measurements had been made to the west of Point Aconi in the vicinity of Bird Island. In response, J. Warner reviewed the results of the physical oceanography and sediment dispersion monitoring (refer to Appendices 9[a] and [b]), noting that current strength was generally in the range of 10-15 cm/s. He noted that turbidity levels returned to natural levels within 150 m from the worksite.

(e) Fish behaviour studies involving mackerel

T. Lambert, DFO, raised concerns about the physiological stress placed on the tagged fish during this exercise, and the resultant impacts of this stress on the behaviour of the fish. He noted that mackerel is not a hardy fish, and that the stress due to the catching, tagging and following operations would be significant, and as a result the fish would not likely behave normally. He also raised the possibility that some tagged fish do not return to their original schools on account of the stress factor and join up with other schools. In response, M. Biagi stated that great care was taken in the selection of the specific fish to tag and their subsequent handling; only large, mature fish in good condition were selected. With respect to the "jumping of schools," he considered this to be rare, and even if it happened he stated that this did not necessarily invalidate the data. In response to a question about the use of other tagging methods it was stated that there was not sufficient time to investigate/implement these. The meeting acknowledged that the system used represented a novel approach.

9. DEVELOPMENT OF HABITAT STATUS REPORT CONCLUSIONS, RECOMMENDATIONS AND ADVICE

D. Scarratt noted that there are historical data available in order to undertake an assessment of the long-term effects of the dredging, and he urged that such an analysis should be undertaken, e.g., of fish catches before and after the project. In terms of the direct impacts of the dredging, he stated that there appears to be sufficient evidence to indicate that these are minimal, probably not without some minor effects but not significant. With respect to the impacts on fish habitat, particularly bottom (benthic) habitat, he considered that we are not yet in a position to make a statement on this. Further monitoring of the dump sites and artificial reef, as well as the dredged channel bottom, will be required.

At this stage in the meeting there was general consensus that a careful review of the monitoring program and its results had taken place during the day's deliberations. Furthermore, there was consensus that all present had had the opportunity to make their views known. It was considered that there was now sufficient information for the Habitat Subcommittee to proceed with the development of a Habitat Status Report addressing the statement-of-issue. On this basis the chairperson adjourned the meeting (at approximately 1700h.)

Subsequent to the meeting, Prof. John Green of Memorial University's Biology Department, who had been invited to attend the meeting by DFO, submitted his comments with respect to the statement-of-issue. In his report (Appendix 9) he concludes that "...it seems doubtful that I could be convinced that the monitoring program 'allows us to discern the impact of the 1996 dredging operation in Middle Shoal Channel on the movement of fish in and through the channel.' At the same time, based on my consideration of the information discussed at the December 18 meeting, a review of the relevant literature, and experience derived from my own research, I do not believe there was a seriously negative impact on fish populations using Middle Shoal Channel during the dredging project."

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APPENDIX 1

List of invitees and participants

List of Invitees and Participants, Middle Shoal Channel Monitoring Program
Regional Advisory Process (RAP) Meeting,
December 18, 1996 @ BIO

NON - DFO

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Burke, O.	St. Ann's Fishermen's Association General Delivery St. Margarets Village Victoria Co., NS B0J 1R0	(902) 383-2360	(902) 383-2995		✓
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Crawford, B.	N.S. Department of Fisheries PO Box 2223, Halifax, NS B3J 3C4	(902) 863-2521	(902) 863-2521 (902) 424-4671		✓
Dennis, C.	Eskasoni Fish & Wildlife Commission Eskasoni Post Office, NS B0A 1J0	(902) 379-2024	(902) 379-2159	pla_mu@fox.nstn.ca	✓

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Warner, John	Martec Ltd. 1888 Brunswick St., Ste 400 Halifax, NS B3J 3J8	(902) 425-5101	(902) 421-1923		✓

DFO

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APPENDIX 2

Tentative agenda

DFO MARITIMES REGION
REGIONAL ADVISORY PROCESS
HABITAT SUBCOMMITTEE MEETING # 5

December 18, 1996 (9:00 a.m.) Ocean Sciences Boardroom, BIO
Middle Shoal Channel Project (Northern Approaches to the Bras d'Or Lakes)

Scientific Review of Environmental Effects Monitoring Program

TENTATIVE AGENDA

1. Introduction
2. Approval of agenda
3. Background (H.B. Nicholls)
4. Meeting objectives (H.B. Nicholls)
5. Overview and status of Middle Shoal Channel Project (John Fitzgerald)
6. Reports on monitoring:
    - 6.1 Introduction to monitoring program (John Amirault)
    - 6.2 Role of the monitoring committee and involvement of fishermen (Kevin Squires)
    - 6.3 Reports on oceanography monitoring (Jim Warner)
    - 6.4 Reports on sediment dispersion monitoring (Jim Warner)
    - 6.5 Reports on biological and fisheries monitoring (Norval Collins)
7. Discussion and review of monitoring program results with respect to statement-of-issue[1]
8. Development of Habitat Status Report conclusions, recommendations and advice.

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[1] *Statement of Issue*:

> *Does the monitoring program developed and undertaken by the proponent, along with scientific expertise derived from other such projects and general scientific theory, allow us to discern the impact of the 1996 dredging operation in Middle Shoal Channel on the movement of fish in and through the channel, and on fish habitat.*

APPENDIX 3

Schedule of Middle Shoal RAP #1 and RAP #2 Review Process

Schedule of Middle Shoal RAP # 1 and RAP # 2 Review Processes

RAP # 1 - Review of Middle Shoal Monitoring Program Design and Data (Approximate Dates)

December 18 and 19, 1996	LNG to present data and interpretation. Peer Review Meeting to be held at BIO.
Week of January 27, 1997	Habitat Status Report to be drafted and finalized. Approval by Steering Committee.
Week of February 3, 1997	Report to be forwarded to RDG, Department of Fisheries and Oceans for approval.
Week of February 17, 1997	Final RAP Report to be released and distributed.

RAP # 2 - Reconsideration of July 15, 1996, Middle Shoal Assessment Decision (Approximate Dates)

Week of February 3, 1997	Peer Review meeting to be held at BIO.
Week of March 17, 1997	Habitat Status Report to be drafted and finalized. Approval by Steering Committee.
Week of March 24, 1997	Report to be forwarded to RDG, Department of Fisheries and Oceans for approval.
Week of April 7, 1997	Final RAP Report to be released and distributed.
Week of April 21, 1997	Revised Screening Report to be submitted to RDG, Department of Fisheries and Oceans and RDG, Environment Canada.

DFO MARITIMES REGION
SCIENCE BRANCH
REGIONAL ADVISORY PROCESS (RAP)
MIDDLE SHOAL CHANNEL IMPROVEMENT PROGRAM

Revised Schedules (18 Feb., 1997)

Environmental Effects Monitoring Program

December 18, 1996	*RAP Meeting held at BIO.* *Proponent tabled draft Environmental Monitoring Report.*
January, 1997	*Proceedings of RAP Meeting drafted ; undergoing internal review in DFO.*
February, 1997	*Proceedings of RAP Meeting issued.*
March, 1997	*Consensus reached on content of Habitat Status Report; final draft version available.*
April, 1997	*Habitat Status Report issued.*

Reconsideration of July 15, 1996 Screening Report Assessment Decision

March, 1997	*RAP Meeting in Cape Breton*
March, 1997	*Proceedings of RAP Meeting drafted*
April, 1997	*Proceedings of RAP Meeting issued.*
May, 1997	*Consensus reached on content of Habitat Status Report; final draft version available.*
May, 1997	*Habitat Status Report issued.*

APPENDIX 4

Overview and status of Middle Shoal Channel Program

Presented By:

Mr. John A. Fitzgerald, P.Eng.
Program Manager
Middle Shoal Project
USG Canadian Mining Corp.

Company Background

- Company operates two gypsum facilities in Nova Scotia
- Stable operations in Nova Scotia since 1935
- Payroll of 250 – 300 employees
- Annual shipments of approximately 3 million tons

Competitive Situation

- LNG vessels increasingly underutilized from 60–80% of capacity.
- Competition from foreign and synthetic sources increased in the last decade.
- Delivered product cost uncompetitive in 1990s.
- LNG problem — depth restrictions at Middle Shoal.

Project Development

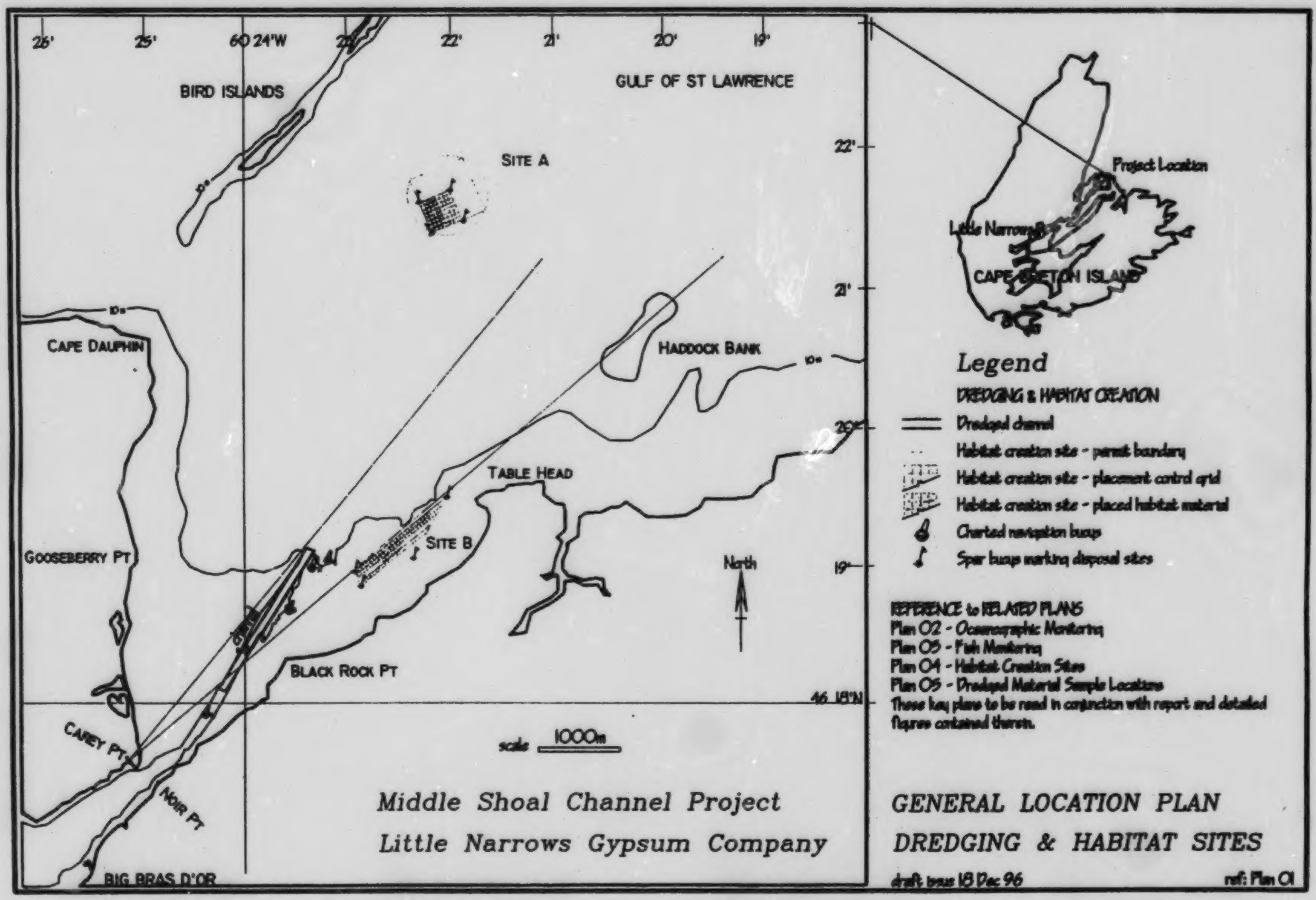
- Technical Investigations — 1985 – 1987
- Procedural, Engineering & Approval Process Investigations — 1988 – 1994
- Cost / Benefit Studies — 1995
- Environmental Assessment Process — 1995 – 1996
- Regulatory and Financial Approvals & Implementation — 1996

Environmental Assessment

- Community and stakeholder consultations
- Technical, oceanographic and fishery investigations
- Government relations
- Environmental submissions and permit applications

Project Management

- Engineering Design
- Environmental Management Plan
- Community / Stakeholder Involvement
- Critical Path Planning
- Implement During Tight Operational “Window”


26'
25'
60 24'W
23'
22'
21'
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19'
BIRD ISLANDS
GULF OF ST LAWRENCE
SITE A
22'
21'
20'
19'
46 18'N
10m
CAPE DAUPHIN
HADDOCK BANK
TABLE HEAD
SITE B
GOOSEBERRY PT
North
BLACK ROCK PT
CAREY PT
NOIR PT
BIG BRAS D'OR
scale 1000m
Project Location
Little Narrows
CAPE BRETON ISLAND

Middle Shoal Channel Project
Little Narrows Gypsum Company

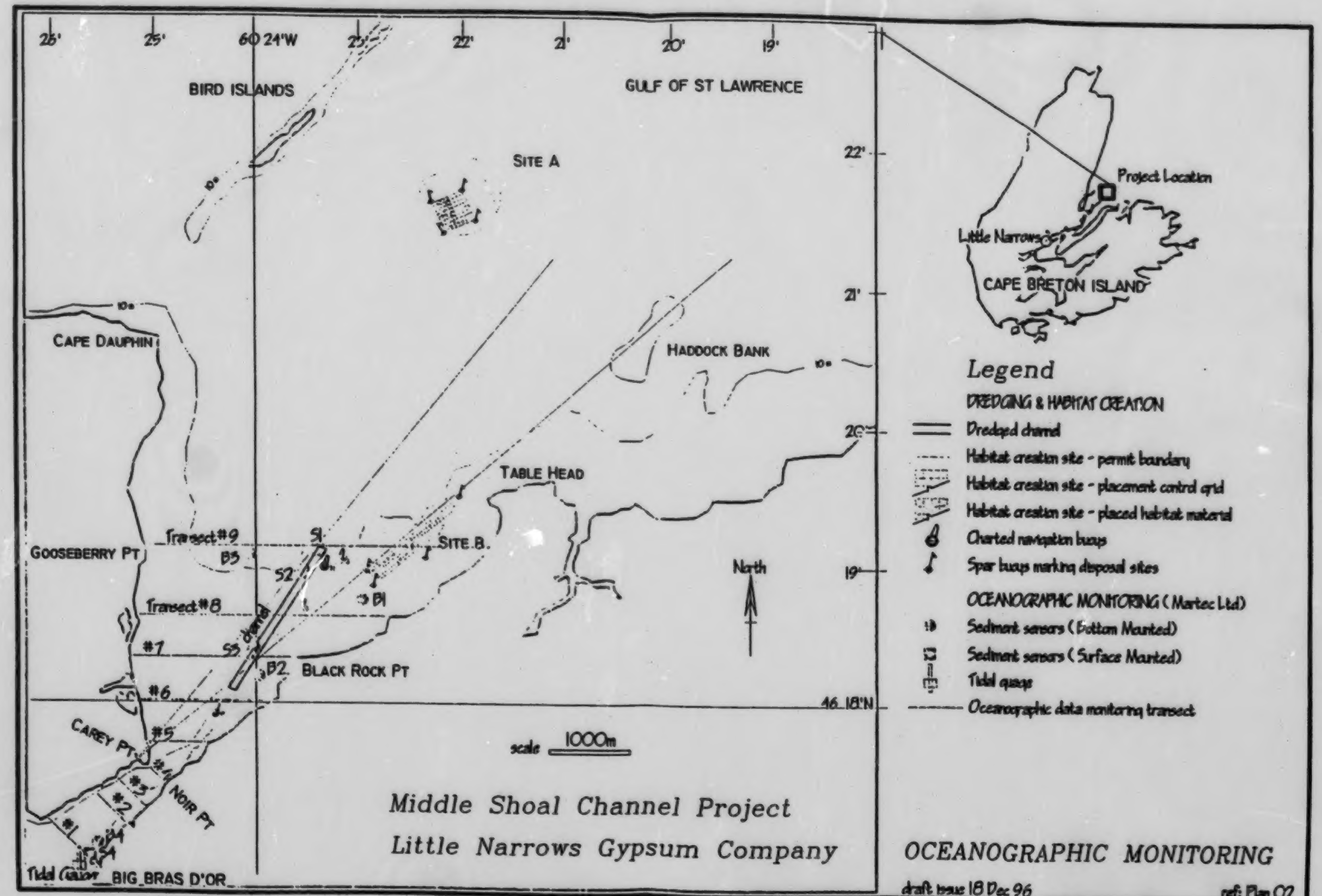
Legend

DREDGING & HABITAT CREATION
- Dredged channel
- Habitat creation site - permit boundary
- Habitat creation site - placement control grid
- Habitat creation site - placed habitat material
- Charted navigation buoys
- Spar buoys marking disposal sites

REFERENCE to RELATED PLANS
Plan 02 - Oceanographic Monitoring
Plan 03 - Fish Monitoring
Plan 04 - Habitat Creation Sites
Plan 05 - Dredged Material Sample Locations
These key plans to be read in conjunction with report and detailed figures contained therein.

GENERAL LOCATION PLAN
DREDGING & HABITAT SITES

draft issue 18 Dec 96
ref: Plan 01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25'
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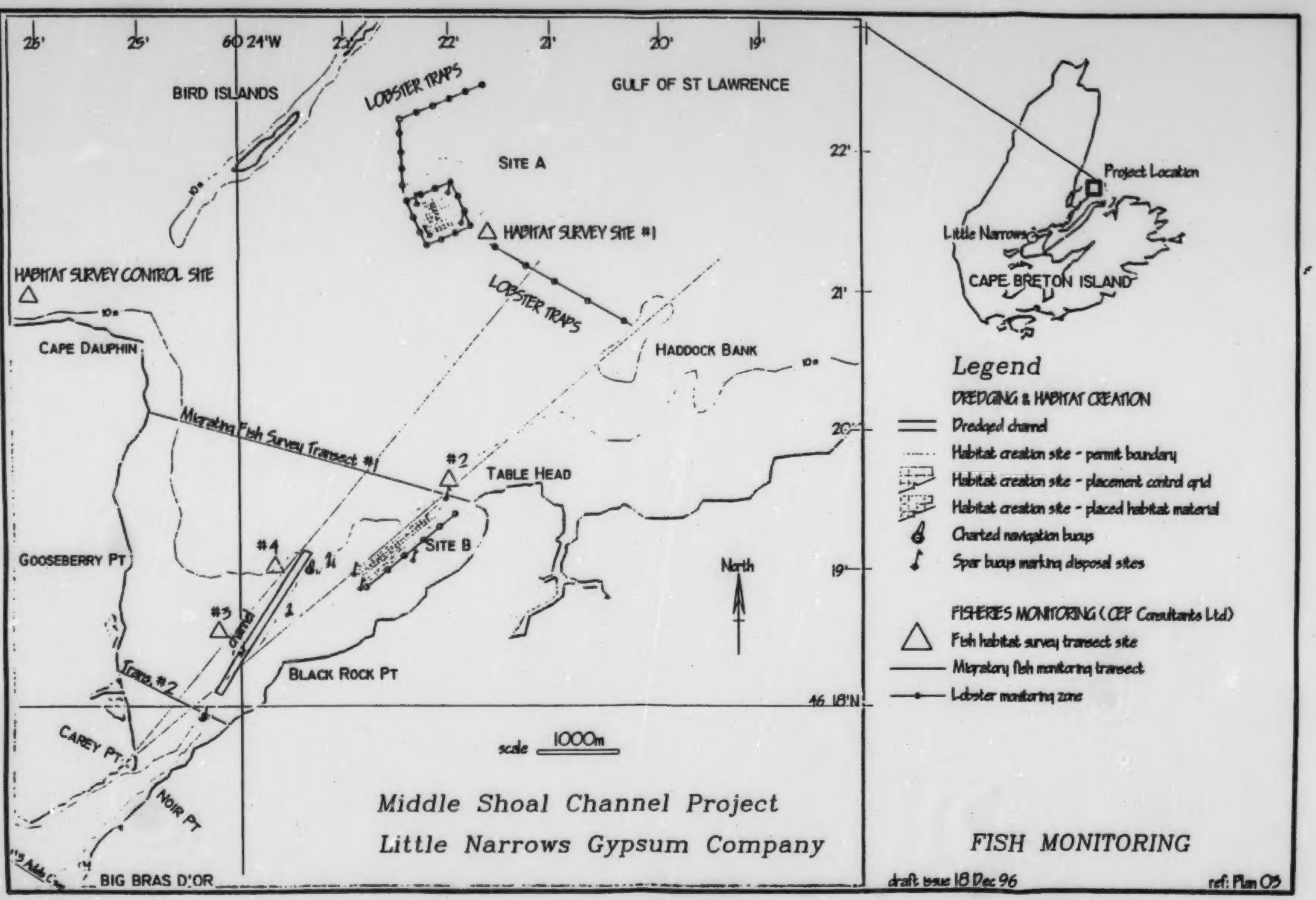
19'
BIRD ISLANDS
GULF OF ST LAWRENCE
SITE A
CAPE DAUPHIN
HADDOCK BANK
TABLE HEAD
SITE B.
GOOSEBERRY PT
Transect #9
B3
S1
S2
B1
Transect #8
#7
S3
B2
BLACK ROCK PT
#6
CAREY PT
#5
#4
#3
#2
#1
NOIR PT
Tidal Gauge
BIG BRAS D'OR
North
scale 1000m
22'
21'
20'
19'
46 18'N
Project Location
Little Narrows
CAPE BRETON ISLAND
Legend
DREDGING & HABITAT CREATION
Dredged channel
Habitat creation site - permit boundary
Habitat creation site - placement control grid
Habitat creation site - placed habitat material
Charted navigation buoys
Spar buoys marking disposal sites
OCEANOGRAPHIC MONITORING (Martec Ltd)
Sediment sensors (Bottom Mounted)
Sediment sensors (Surface Mounted)
Tidal gauge
Oceanographic data monitoring transect
Middle Shoal Channel Project
Little Narrows Gypsum Company
OCEANOGRAPHIC MONITORING
draft issue 18 Dec 96
ref: Plan 02


26'
25'
60 24'W
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19'
BIRD ISLANDS
LOBSTER TRAPS
GULF OF ST LAWRENCE
SITE A
HABITAT SURVEY SITE #1
HABITAT SURVEY CONTROL SITE
LOBSTER TRAPS
CAPE DAUPHIN
HADDOCK BANK
10m
Migrating Fish Survey Transect #1
#2
TABLE HEAD
#4
SITE B
GOOSEBERRY PT
#3
North
Trans. #2
BLACK ROCK PT
46 18'N
CAREY PT
scale 1000m
NOIR PT
BIG BRAS D'OR
22'
21'
20'
19'
Project Location
Little Narrows
CAPE BRETON ISLAND
Legend
DREDGING & HABITAT CREATION
Dredged channel
Habitat creation site - permit boundary
Habitat creation site - placement control grid
Habitat creation site - placed habitat material
Charted navigation buoys
Spar buoys marking disposal sites
FISHERIES MONITORING (CEF Consultants Ltd)
Fish habitat survey transect site
Migratory fish monitoring transect
Lobster monitoring zone
draft issue 18 Dec 96
ref: Plan 03

Middle Shoal Channel Project
Little Narrows Gypsum Company

FISH MONITORING

Project Status

- Project commenced 20 August 1996
- Worked 20 hour days, maximum 10 days
- Material used for fish habitat sites
- Four clamshell dredges moved 336,000 cm to habitat creation sites
- Project ended 24 October 1996
- Permits suspended pending re-assessment of aboriginal food fishery issue
- Concluded field monitoring 15 November 1996

Future

- Submit Monitoring Report / RAP Process
- Resolution of court order requirement
- Company and regulators assess existing new Channel
- Future Decision — Utilize Channel as is or finish remaining work

APPENDIX 5(a)

Middle Shoal Channel Program, Monitoring Committee Members & Mandate

DRAFT.....18 Dec. 1996

Middle Shoal Channel Program
Environmental Monitoring Committee

Membership

Mr. Kevin Squires - Chair
Great Bras d'Or Fishermen□s Group - Mr. Donald F. MacDermid, Sr.
Great Bras d'Or Community - Ms. Regina Reid
Fisheries and Oceans Canada - Ms. Joan Reid
Environment Canada - Mr. Adrian MacDonald
Nova Scotia Fisheries - Mr. Robert Crawford
Union of Nova Scotia Indians - Mr. Ivan Rafuse (DIAND)
Project Management Group - Mr. John A. Amirault, P.Eng.

Ex-officio

Little Narrows Gypsum - Mr. John Fitzgerald, P.Eng.
Beaton Institute UCCB - Mr. Sander Taylor

Mandate

☐ To assemble an informed group of persons to provide vigilance with respect to environmental and community issues in relation to the Middle Shoal Channel Program.

☐ The committee will review environmental effects monitoring activities which are directed to confirm environmental assessment predictions.

☐ The Monitoring Committee will participate in decisions taken to mitigate adverse environmental effects.

☐ The committee will participate in any adjustments to the monitoring plan from time to time.

☐ To provide an effective alternate liaison and communication vehicle for stake holders to comment on and communicate with project managers and regulatory agencies.

☐ To meet government requirements to maintain effective consultation with the stakeholder community.

☐ To provide advice and comment to project management

APPENDIX 5(b)

Notes on involvement of fishermen

When John Fitzgerald first broached the idea of dredging the channel at Big Bras d'Or with our Fishermen's Group, I don't believe he was prepared for either the strength, or the unity of the opposition he encountered. That opposition had two main causes: one, our fishing community shares with every other like it, a sense of fear for its future, and the last thing anyone needed was another threat to their livelihood; and two, local experience with industrial development - which includes one strip mine, one gravel and limestone quarry, and the infamous Point Aconi Power Plant - has been less than satisfying. Either we had absolutely no say at the beginning of a given project, we were effectively excluded from discussions as the project developed, or we were unable to arouse the attention of regulators when environmental damage was observed to be occurring.

A canvass of local fishers today would, I believe, yield quite positive opinions about this project, and, for that matter, about its proponents. The simple answer to how that change came about might be that local fishers are pleased to have found some work for themselves and their boats during the project. While that is true, it is important to remember who you are dealing with - with this season behind them, fishermen are now firmly fixed on the season ahead - and if there were any doubts about the good conduct of this project, or possible negative impacts, you would certainly be hearing them now. In fact, the reasons for our apparent change of face can be found in our own local history, and in the history of this project itself.

Almost twenty years ago, I first met Brian Thompson, when our wharf needed rebuilding and the standard design didn't suit us very well. So for six months or more, we exchanged letters and visits, until we had arrived at a mutually agreeable plan. Although this meant quite a delay in getting much-needed repairs, we were willing to take the time to do it right - as long as we had someone who was willing to work with us.

Then in 1990, with a number of the projects referred to earlier in progress, we proposed to local DFO Habitat personnel a means to gain some base line information about the local fishing environment before these projects changed anything - we would provide boats and manpower if they would find underwater camera equipment to film certain sensitive areas. Although that proposal yielded only one morning of filming - and nearly got my boat blown ashore - the point is that we were willing and available to co-operate for common purposes.

More recently, we discussed with John Pringle, the possibility of organizing a seminar on the lobster fishery, primarily on what actions local groups could identify and act on to enhance their industry. And for a few years now, we have been working with John Tremblay and Mike Eagles on lobster tagging studies. In fact, before this project was ever approved, we had asked Mike and John for suggestions of studies or work that could be carried on during its progress. We intended, if this work was to occur, to be very much involved in watching how it was being done, and in gaining the maximum amount of information from it.

But this is getting a bit ahead, because the change form opposition to acceptance didn't happen overnight. When it became obvious that LNG wasn't going to go away just because we hollered and shook our fists, we sought other opinions on their proposal. Provincial environment officials, federal fisheries and environment personnel, private consultants, university instructors, as well as a ship's pilot, were all contacted for their opinions on what this project might mean in terms of their own expertise. When these inquiries failed to turn up any great threats, we took the next step of requesting financial support from the proponent, for the purpose of hiring independent, outside expertise to review their work. This was provided and the subsequent study, while saying that the work would not be in the best interest of the fichermen, also pointed out that most, "... impacts are either unlikely, of minor significance or both." Further, it stated that, "... for an engineering project of its size, the proposed dredging would carry remarkably few problems." When our study went on to note that monitoring the project could be beneficial both immediately and for future research, particularly, "... if it was co-directed by the fishermen and so helped them develop the skills they will need in the co-managed fisheries of the future", it seemed to speak directly to our history. Without good, strong reasons for continued opposition, and with our past attempts to co-operate for mutual benefit seeming to fit the idea of co-directing a monitoring program, we changed our position, based on a firm commitment to establish and conduct a comprehensive monitoring plan which we would be intimately involved with. And that is what I believe we have seen.

In establishing this monitoring program, we had three main points of interest, which were the disposition of sediment from both dredging and dumping, the effect of dredging on the movement of fish, and possible losses of lobsters in both dredge and dump sites. Each of these has been attended to our satisfaction. In practice, our involvement in monitoring these areas has guided the selection of areas for sounder calibration, sediment monitoring, habitat transects, routine fish monitoring and fish tracking; we have been involved in the design and conduct of lobster monitoring; we have provided, built, modified and employed much of the gear which has been used in this program; we have overseen the inspection, approval and placement of dredged material on selected sites; and we have received and reacted to information provided as the project proceeded. And I can personally take credit for dissuading the environmental team from pursuing the idea of bringing mobile fishing gear in to aid fish species identification: that that might now appear to have been a misjudgement is unfortunate, but it does indicate the degree to which we participated and were heard.

One of the ways we assured a very high level of involvement in this project was by assuming responsibility for hiring required labour, and for providing all shore-based boat services. Given that up to thirty crew members, and eight boats per day might be required for a range of jobs, that meant we had to learn a great deal about scheduling, human relations, and generally managing complex affairs. I believe we held up our end of the deal very well, and has been an excellent experience in co-operation and group accomplishment for all of our fishers.

Finally, we have been eyes and ears constantly scrutinizing the project for possible problems, using people whose future livelihood depends on this project having no lasting harmful effect, and drawing on all available local input. The value of local contact was made quite clear when, early in the project, fishermen from another port raised questions about possible damage to cod habitat. Our members immediately contacted DFO personnel on this matter, clarified local knowledge and involvement, and seemed to have made necessary improvements to the situation. Further, throughout this project, when it was coming under public scrutiny and criticism, our local contacts made it possible to keep accurate information flowing to those who requested it; and we made a point of inviting both the press, and fishers from other ports, to visit and comment on the monitoring program and possible improvements to it.

It is quite obvious, then, that I am more than satisfied by how this project has accommodated our need to be involved for the protection of our community interests, and I think the manner in which that was accomplished might well be used by others involved in industrial projects, as a model for community development, especially in its human resources. But that is not to say that no improvements could have been made. More lead time to prepare for our monitoring role would have allowed us to bring in people to advise us on what to watch for and how to do it. For that matter, it would have been beneficial to have continued to rely on an independent consultant throughout the project, to provide current comment on information being gathered. Better communication and greater attention from DFO might have eliminated problems, as well as given the opportunity to accomplish more in the field of local research. And for our own part, although our core management group was kept up to date on the project, we could have made more time for all our members to receive and discuss reports from those responsible to conduct the various programs.

In a lot of ways, I am the wrong person to comment on local reaction to this project. Rather, some of our members who were most adamant in their early opposition would now tell you that their concerns were addressed, and that they are satisfied with our participation in the monitoring programs which accomplished that And in one instance where that participation crossed generations, his daughter's involvement as an environmental technology student helped one of our fishermen change his perspective on this project. Where he had seen only risks, his own presence during the work, and the knowledge that his daughter's training was being employed in the conduct of the programs has given him a great deal of comfort.

So finally I will close with the comment that I do not want to be seen as a cheerleader for either this project or those people who ran it. It would be naive in the extreme to believe that there was no risk involved, or that we could possibly have foreseen all impacts. But as a person who has seen a number of these sorts of projects, I must say that this one was the most willing to recognize local concerns and needs, and to make room for the community to take some responsibility for its own future.

APPENDIX 5(c)

Middle Shoal Program Environmental Monitoring Committee

MIDDLE SHOAL PROJECT
ENVIRONMENTAL MONITORING COMMITTEE

Presented By:

Mr. Kevin Squires,
Chairman of Committee

NOTE: This presentation was originally made in narrative form. The attached represents a summation of key points.

EARLY REACTION TO PROJECT

First approach was met with negative reaction by local fishermen, based on:

- Fear of future.
- Poor experience with previous industrial projects.
- Usually excluded from project process.

CURRENT POSITION OF LOCAL FISHERS

- Quite positive opinions about this project and proponents.
- Yes, a work opportunity, but…
- If there were concerns, we would be hearing of them now.

BACKGROUND

- First met Brian Thompson of DFO, almost 20 years ago.
- 1990 — Habitat baseline information project.
- More recently, John Pringle re lobster fishery seminars.

MIDDLE SHOAL PROJECT

- We realized Little Narrows Gypsum and the project were not going to go away.
- Request financial support from Little Narrows Gypsum to examine project and data.
- Independent study concluded *"impacts are unlikely; of minor significance"*.
- Changed our thoughts to a possible role co-directing and monitoring project.

Middle Shoal Project, cont...

- Three points of interest:

1. Disposition of sediment
2. Movements of fish.
3. Possible lobster loss at dredge and dump sites.

HOW WE WERE INVOLVED

- Established our own needs.
- Active involvement in Monitoring Committee.
- Field work for oceanographic and fish monitoring.
- Provision of equipment and personnel to monitor.
- Provision of equipment and personnel to staff work operations.
- Encouraged and invited press and other ports to visit and comment on monitoring program.

AREAS FOR IMPROVEMENT

- More lead time for role.
- Hire independent consultant to comment on ongoing process.
- Encourage better communication and greater attention from DFO.

OUR CONCLUSION

- Our concerns were addressed.
- Satisfied with our participation in the monitoring program.
- The project was willing to recognize local concerns and needs.
- It made room for the community to take some responsibility for its own future.

APPENDIX 6

Middle Shoal Channel Program Introduction

Presented By:

Mr. John A. Amirault, M.Eng., P.Eng.
Environmental Studies Coordinator
Middle Shoal Project
Little Narrows Gypsum Company

Middle Shoal Channel Project

- Participants

John Fitzgerald
John Amirault
Peter Dwyer
Kevin Squires
Jim Warner et al
Norval Collins et al

Middle Shoal Channel Project

- **Environmental Program** John Amirault
- CEAA Scoping
- Screening Level Assessment
- DFO Lead Responsible Agency
- Environmental Review Document
- Stakeholders
- Screening Report
- Environmental Management Plan
- Environmental Monitoring
- RAP

Competitive Situation

- LNG vessels increasingly underutilized from 60–80% of capacity.
- Competition from foreign and synthetic sources increased in the last decade.
- Delivered product cost uncompetitive in 1990s.
- LNG problem — depth restrictions at Middle Shoal.

Project Development

- Technical Investigations — 1985 – 1987
- Procedural, Engineering & Approval Process Investigations — 1988 – 1994
- Cost / Benefit Studies — 1995
- Environmental Assessment Process — 1995 – 1996
- Regulatory and Financial Approvals & Implementation — 1996

APPENDIX 7(a)

Physical oceanography monitoring program

PHYSICAL OCEANOGRAPHY AND SEDIMENT MONITORING PRESENTATION

Presented By:

Dr. J.L. Warner, P.Eng.
Martec Limited

NOTE: These overheads should be read in conjunction with the draft report of 18 December 1996 entitled *"Environmental Monitoring Report on the Middle Shoal Channel Project"*.

OBJECTIVES OF PHYSICAL OCEANOGRAPHY MONITORING PROGRAM

(1) Collect a large pre-dredge oceanographic database which could be directly incorporated into the turbidity monitoring program for identifying sediment plume tracks.

(2) Verify previous hydrodynamic current modelling results for pre-dredge conditions and confirm predicted results of hydrodynamic conditions with channel alterations.

(3) Identify the exchange of water into and out of the lake and compare the measurements for pre-dredge and post-dredge conditions.

(4) Identify regions of stratification and mixing which may influence hydrodynamic modelling results and the dispersion of sediment during the dredging activities.

MIDDLE SHOAL ENVIRONMENTAL MONITORING PHYSICAL OCEANOGRAPHY DATA COLLECTION MONITORING PERIOD: JULY 25 - OCTOBER 17, 1996

Instrument: Acoustical Doppler Current Profiler (ADCP)
Deployment Period: Variable (July 25 - September 7, 1996)

Discharge Data Collected	(1)	Total Discharge Measurements at the Entrance to Great Bras D'Or - July 28 12 hour period = 32 Transects
	(2)	Total Discharge Measurements at the Entrance to Great Bras D'Or - August 11 12 hour period = 36 Transects
	(3)	Total Discharge Measurements at the Entrance to Great Bras D'Or - August 19 12 hour period = 18 Transects
	(4)	Total Discharge Measurements at the Entrance to Great Bras D'Or -August 30 12 hour period = 48 Transects
Transect Data Collected:	(1)	Current Velocity Profiles Across the Outer Entrance (Transect Locations #1 through #9) During Peak Flood Tide
	(2)	Current Velocity Profiles Across the Outer Entrance (Transect Locations #3 through #8) During Peak Ebb Tide
Profiler Data Collected:	(1)	Current Magnitude and Direction Profiles at Dump Sites #A and #B
	(2)	Current Magnitude and Direction Profile Surrounding the Dredging Operation

Continued

Instrument: Tide Gauge with Thermistor Sensor
Location: Duffus Point (7m water depth)
Deployment Period: July 28 to August 31, 1996
Sampling Rate: 10 minute intervals

Data Collected:
(1) Time-Series of Water Elevation and Bottom Water Temperature

Instrument: CTD with OBS Sensor
Location: Variable (2-40 m water depths)
Deployment Period: July 25 to October 15, 1996
Sampling Rate: 2 second intervals

Data Collected:
(1) CTD Profiles During Total Discharge Measurements (July 28, August 11, August 19 and August 30) at the Entrance to Great Bras D'Or.
(2) CTD Profiles at Dump Sites A and B
(3) CTD Profiles Across the Outer Entrance and Surrounding the Dredging Operation

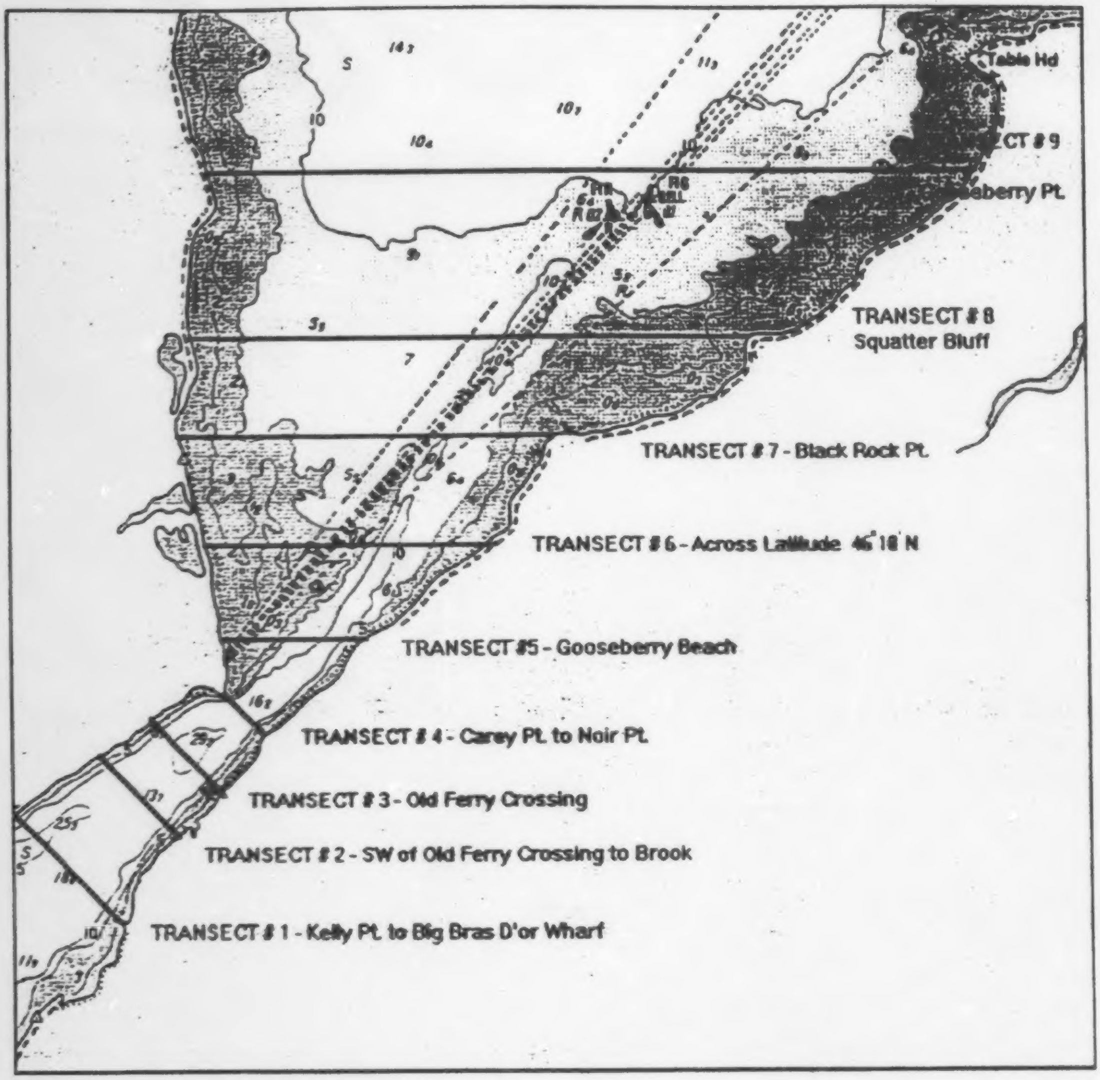
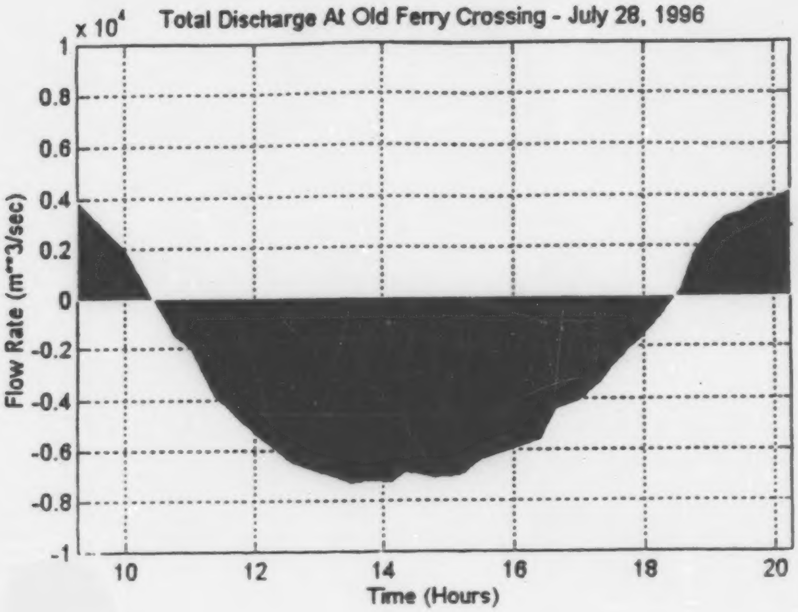
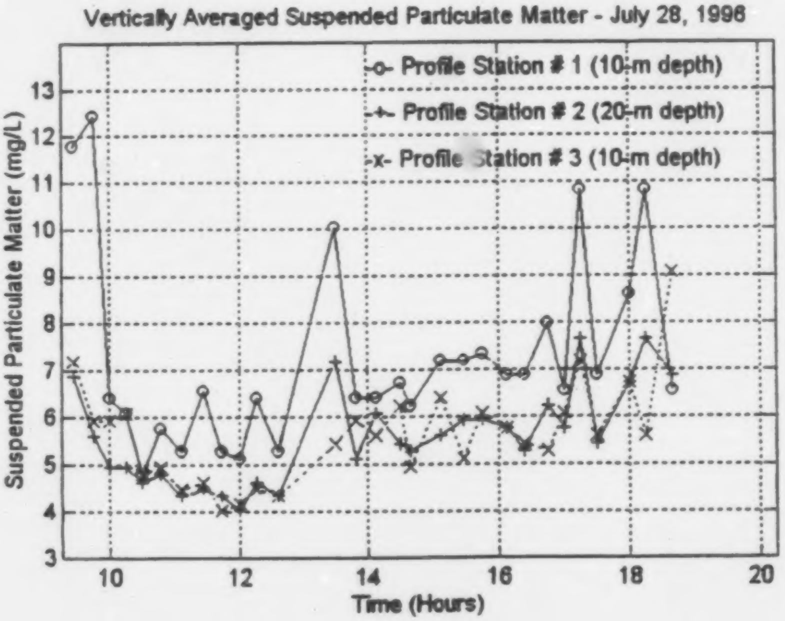


Table Hd
CT # 9
eberry Pt.
TRANSECT # 8
Squatter Bluff
TRANSECT # 7 - Black Rock Pt.
TRANSECT # 6 - Across Latitude 46° 18' N
TRANSECT #5 - Gooseberry Beach
TRANSECT # 4 - Carey Pt. to Noir Pt.
TRANSECT # 3 - Old Ferry Crossing
TRANSECT # 2 - SW of Old Ferry Crossing to Brook
TRANSECT # 1 - Kelly Pt. to Big Bras D'or Wharf

FIGURE 2.1. Location Map of ADCP Survey Transects



Total Discharge At Old Ferry Crossing - July 28, 1996



Vertically Averaged Suspended Particulate Matter - July 28, 1996

FIGURE A.1.1

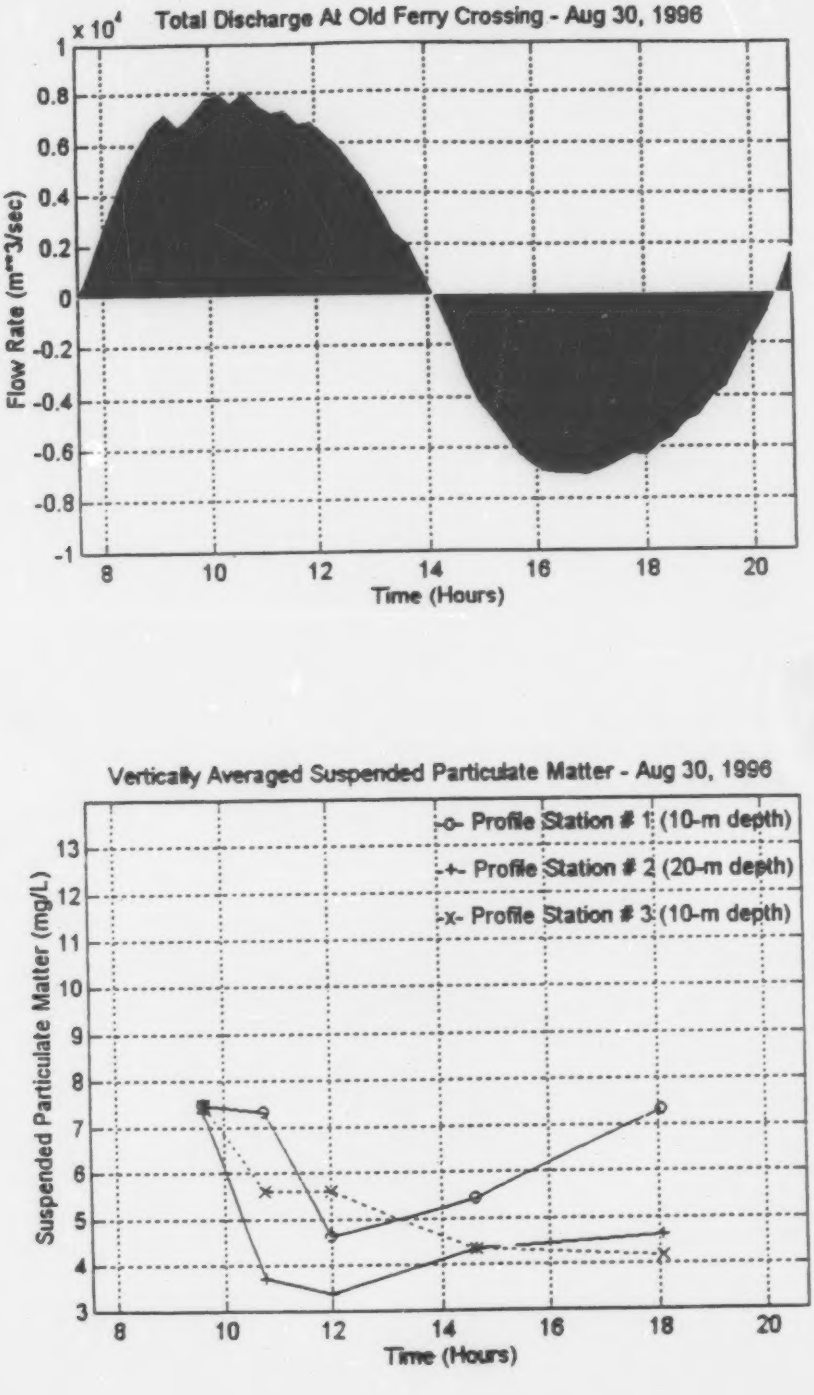

Total Discharge At Old Ferry Crossing - Aug 30, 1996
x 10^4
Flow Rate (m**3/sec)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
8
10
12
14
16
18
20
Time (Hours)
Vertically Averaged Suspended Particulate Matter - Aug 30, 1996
-o- Profile Station # 1 (10-m depth)
-+- Profile Station # 2 (20-m depth)
-x- Profile Station # 3 (10-m depth)
Suspended Particulate Matter (mg/L)
13
12
11
10
9
8
7
6
5
4
3
8
10
12
14
16
18
20
Time (Hours)

FIGURE A.4.1

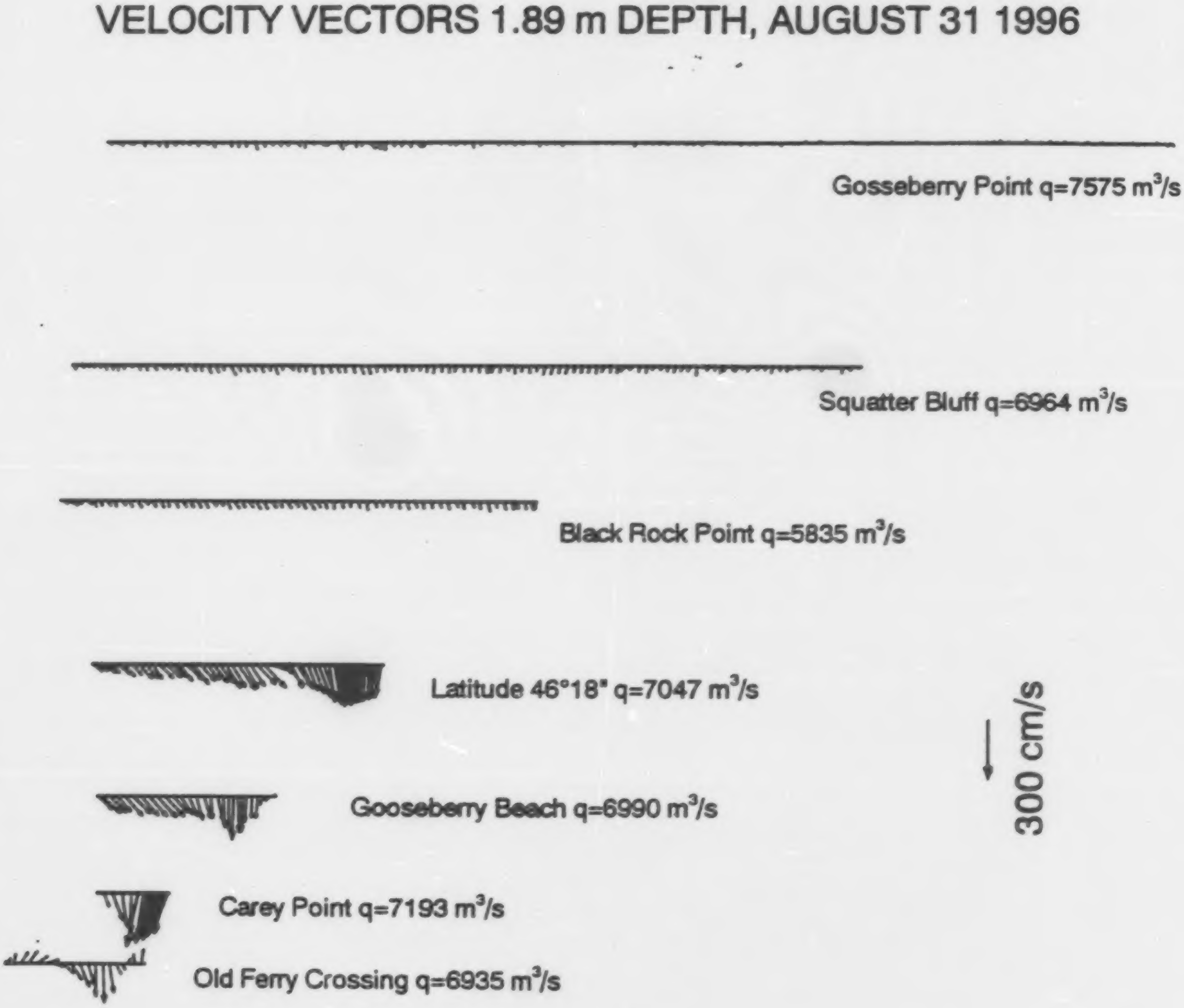
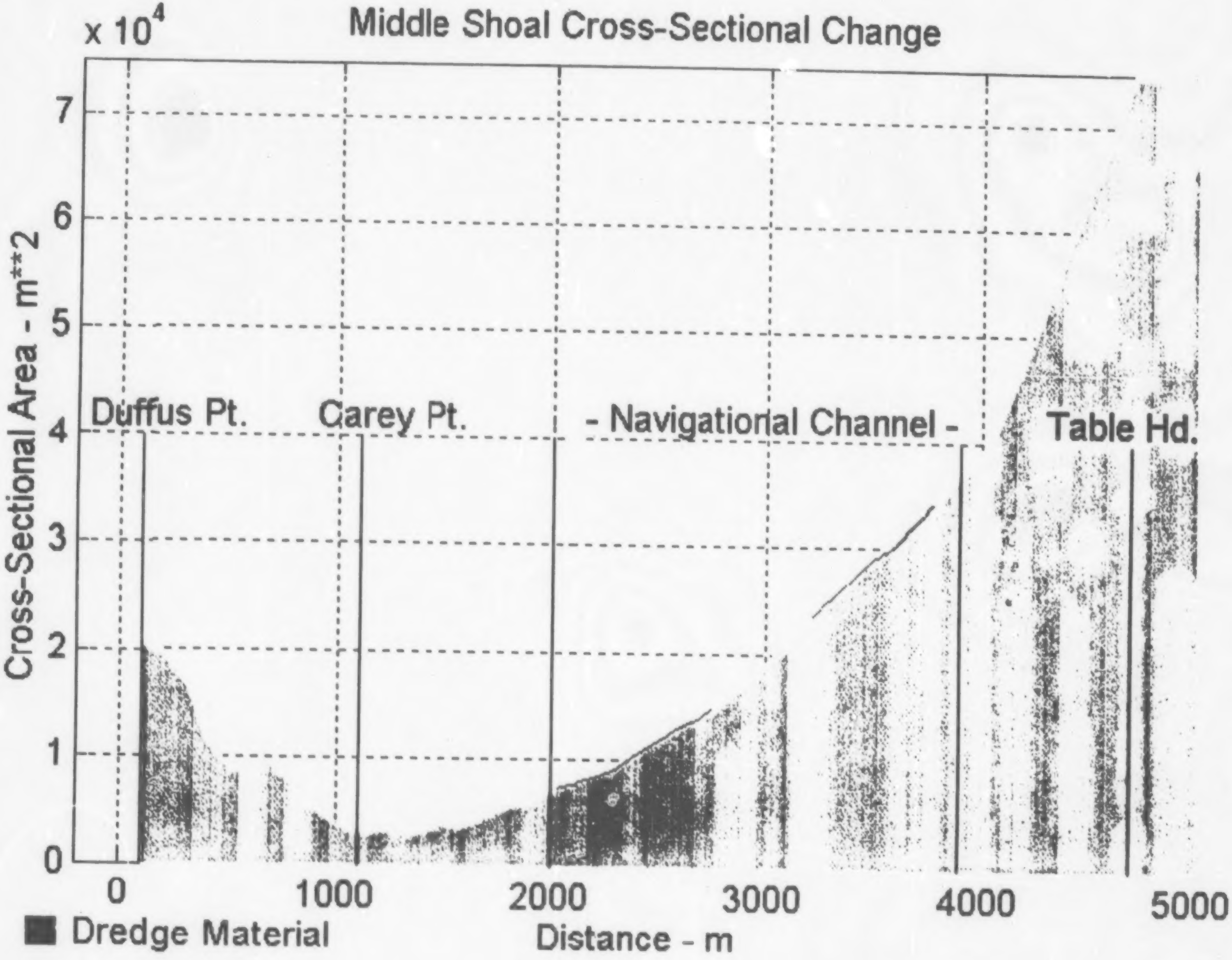
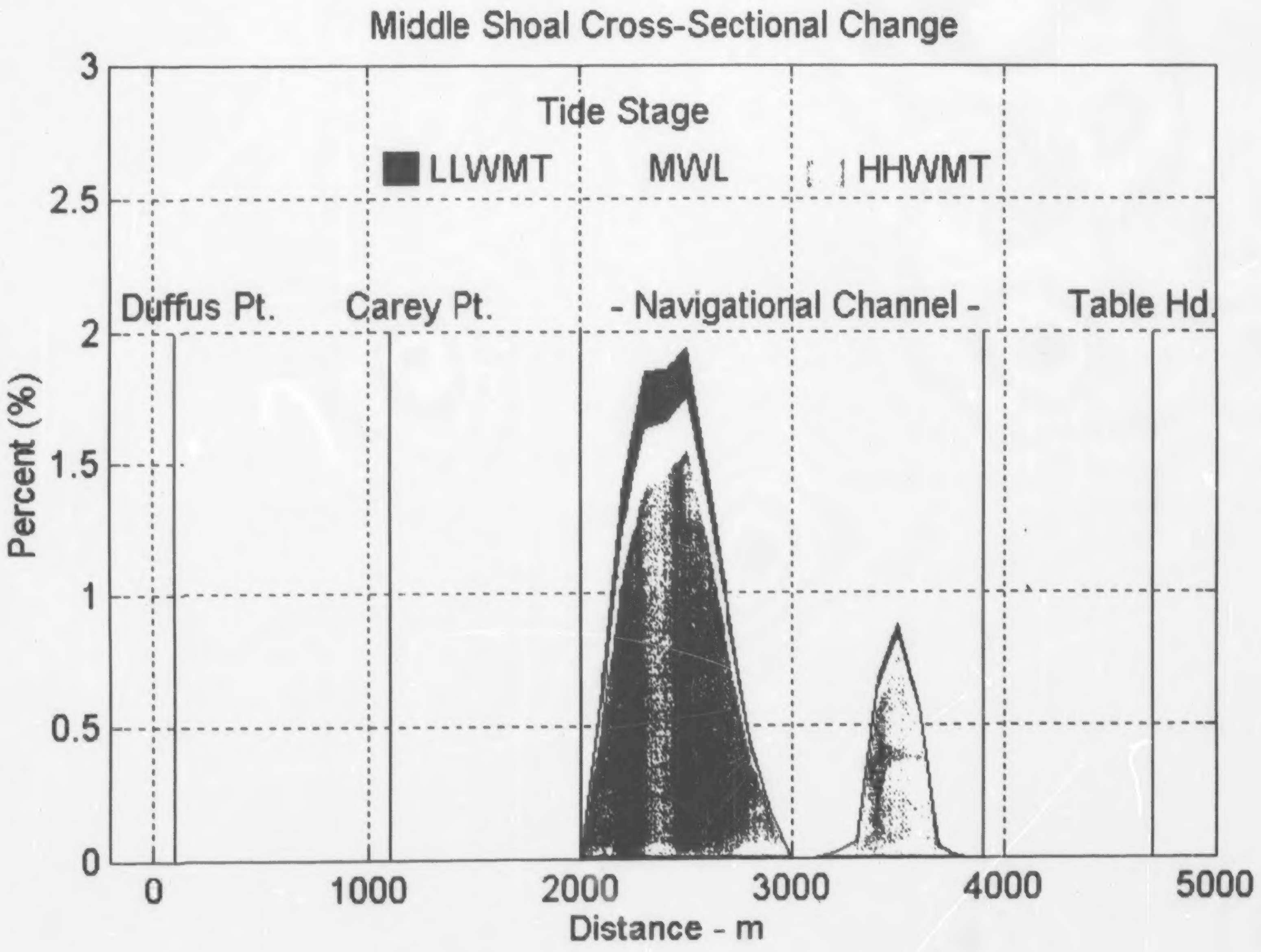


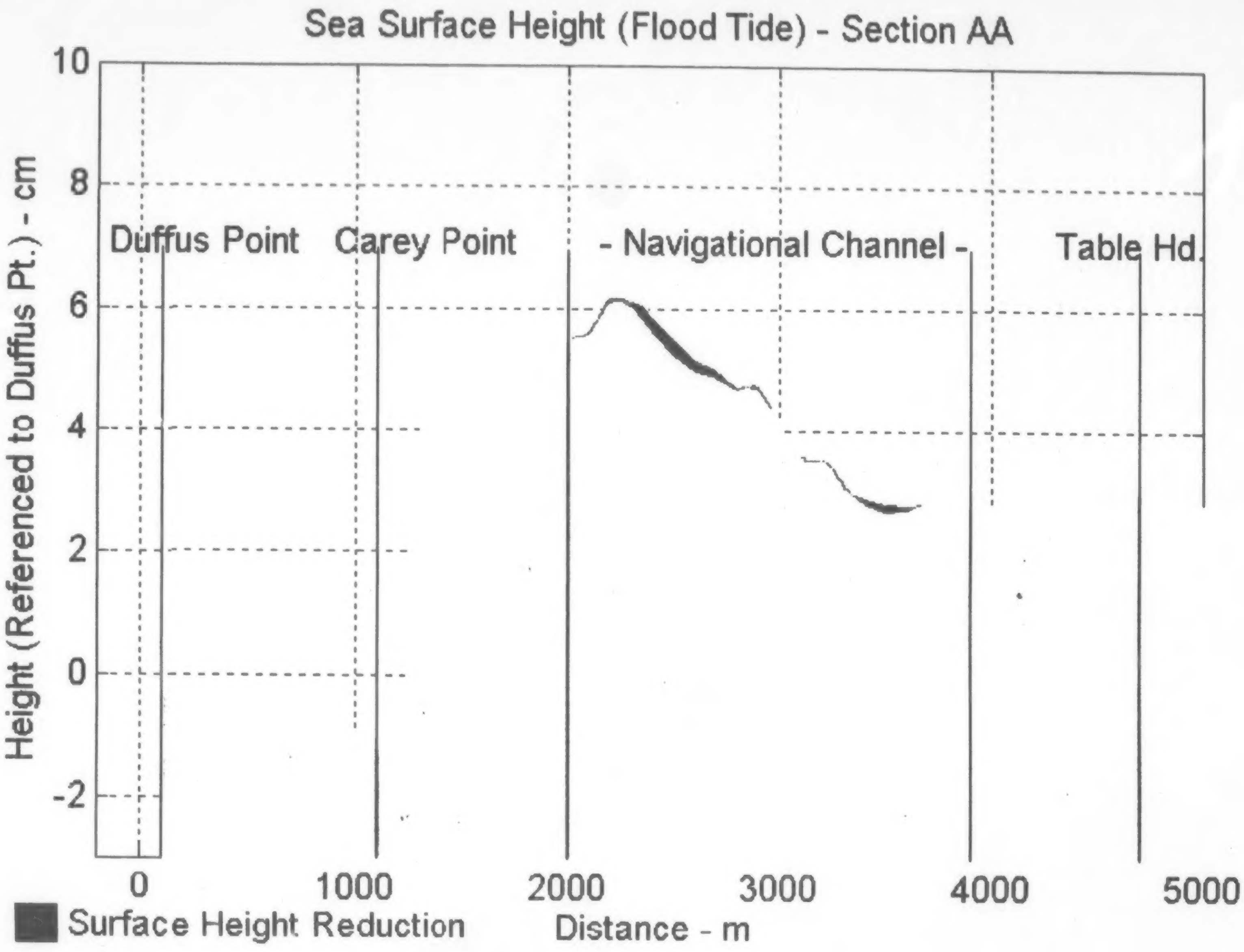
FIGURE 2.6. Velocity Vector Plot - August 31, 1996
(FloodFlow - Transects #3-#9)

PERCENTAGE OF TOTAL FLOW THROUGH NAVIGATIONAL CHANNEL PEAK FLOOD AND EBB FLOWS

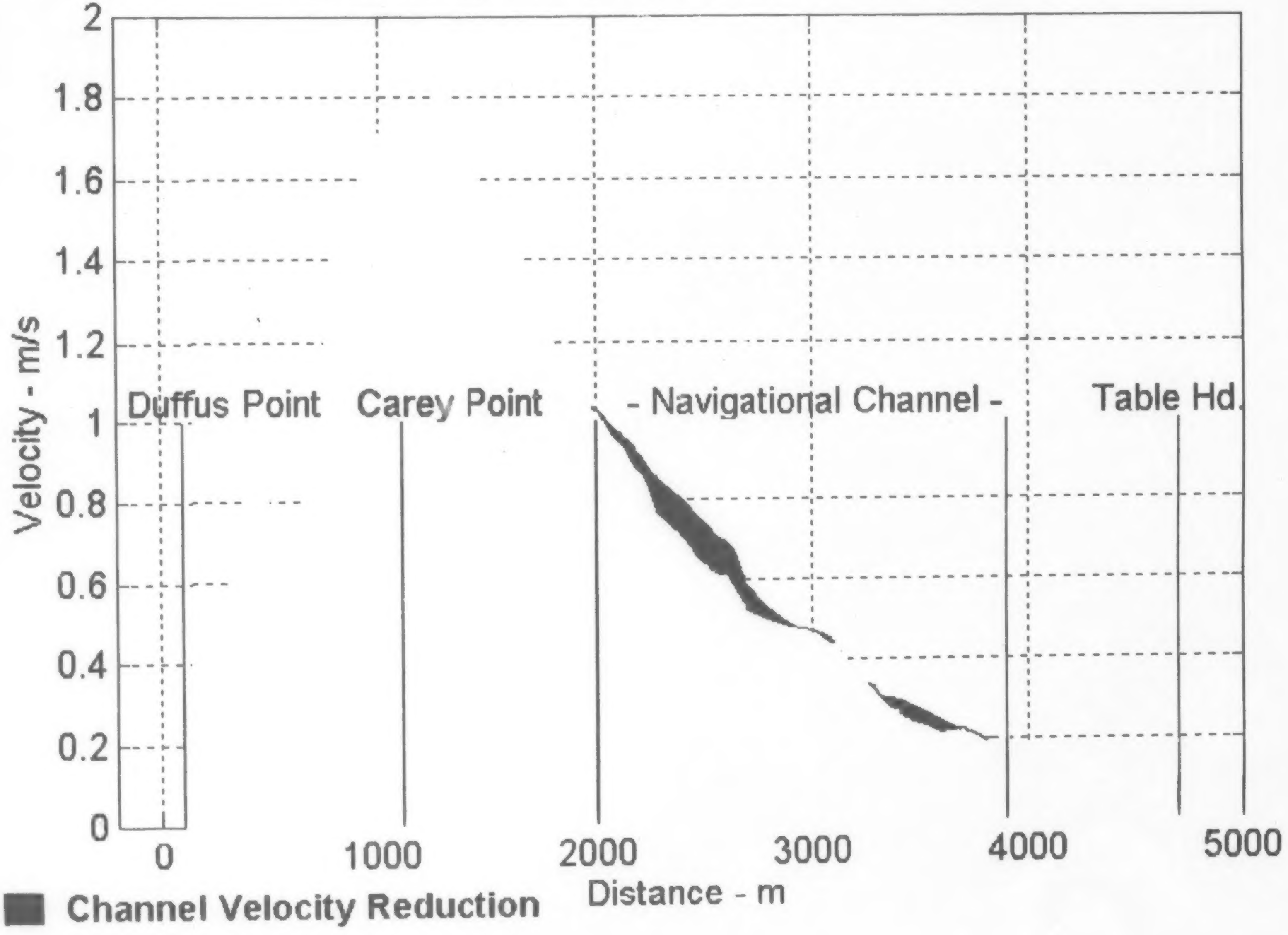
Peak Flow Direction	Transect Position	West Side	100 m Wide Navigational Channel	East Side
Flood Flow (August 31)	Transect #7 Black Rock Pt.	80.9%	8.2%	11.9%
	Transect #8 Squatter Bluff	92.3%	1.8%	5.9%
	Transect #9 Gooseberry Pt.	94.1%	1.1%	4.8%
Ebb Flow (August 22)	Transect #7 Black Rock Pt.	51.8%	23.2%	25.0%
	Transect #8 Squatter Bluff	63.3%	14.3%	22.4%


Middle Shoal Cross-Sectional Change
x 10^4
Cross-Sectional Area - m**2
0
1
2
3
4
5
6
7
Duffus Pt.
Carey Pt.
- Navigational Channel -
Table Hd.
0
1000
2000
3000
4000
5000
Distance - m
Dredge Material


Middle Shoal Cross-Sectional Change
Tide Stage
LLWMT
MWL
HHWMT
Duffus Pt.
Carey Pt.
- Navigational Channel -
Table Hd.
Percent (%)
3
2.5
2
1.5
1
0.5
0
0
1000
2000
3000
4000
5000
Distance - m


Sea Surface Height (Flood Tide) - Section AA
Height (Referenced to Duffus Pt.) - cm
10
8
6
4
2
0
-2
Duffus Point
Carey Point
- Navigational Channel -
Table Hd.
0
1000
2000
3000
4000
5000
Distance - m
Surface Height Reduction

Tidal Velocity Change (Flood Tide) - Section AA



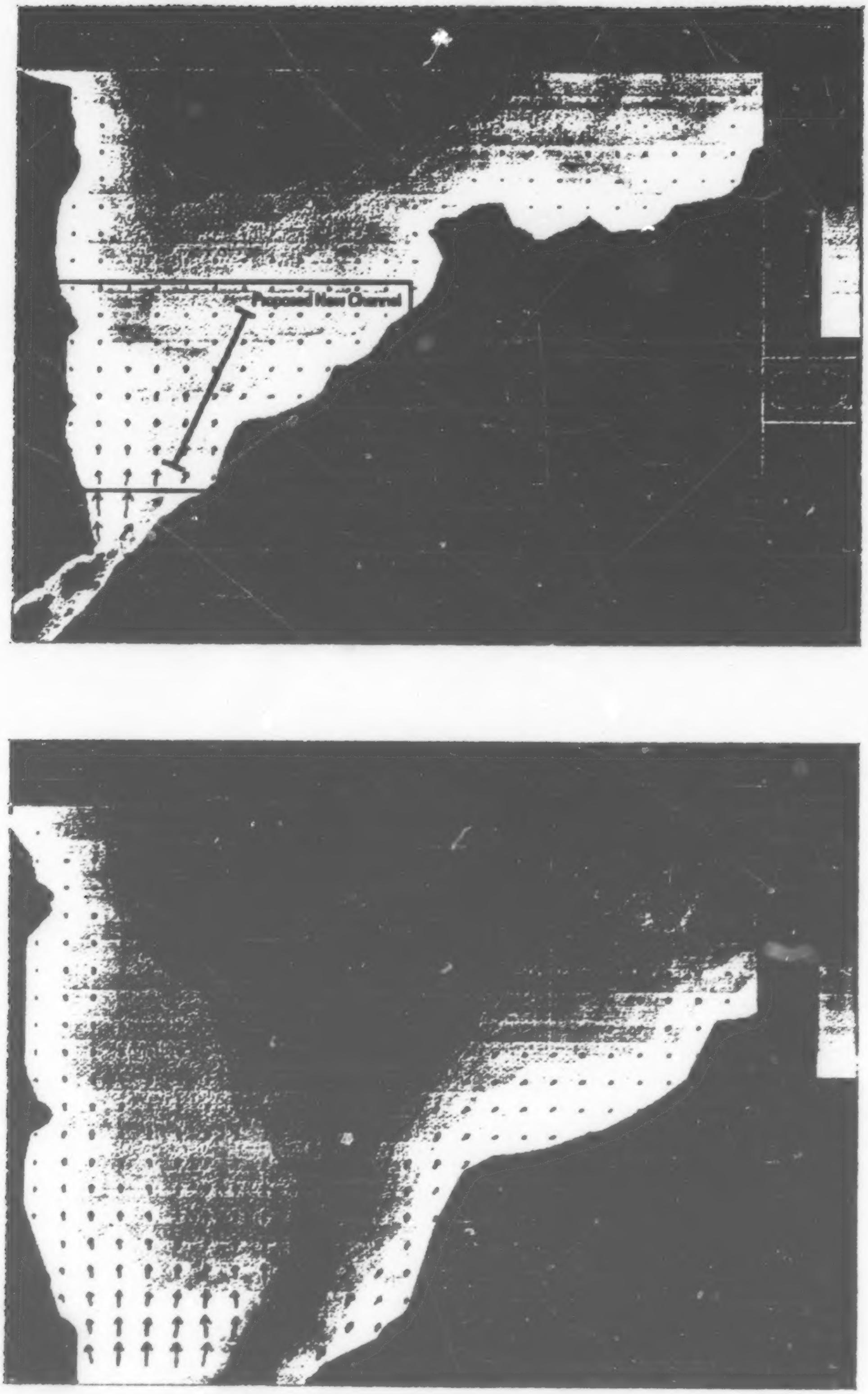

Proposed New Channel

Figure 4.9 Velocity Field During Ebb Tide and a Large Tidal Range
Upper Plot: Grid Size: 8.4 km x 6.5 km Lower Plot: Grid Size: 3.3 km x 2.6 km
(Bathymetry given in Metres)

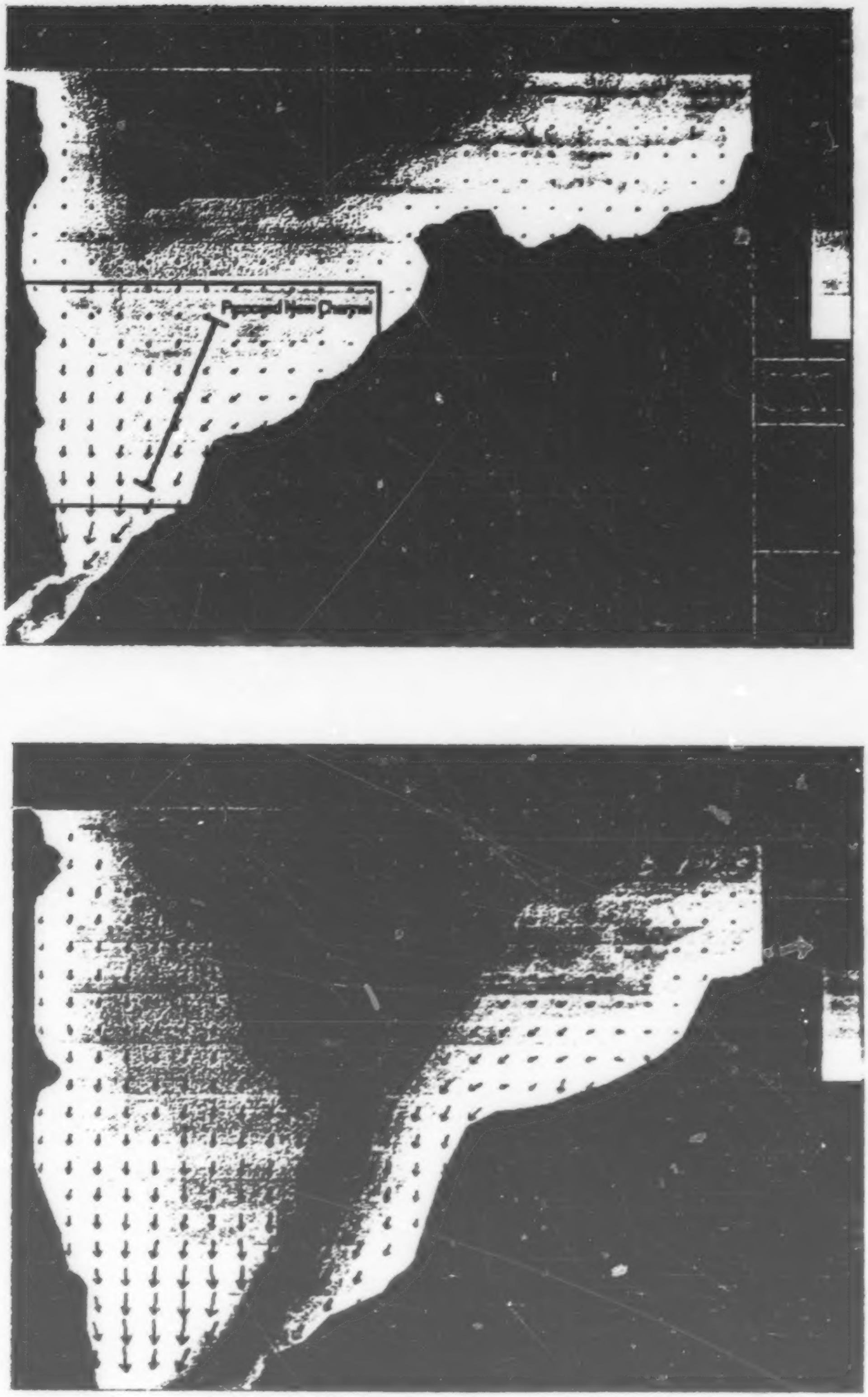


Figure 4.8 Velocity Field During Flood Tide and Large Tidal Range
Upper Plot: Grid Size: 8.4 km x 6.5 km Lower Plot: Grid Size: 3.3 km x 2.6 km
(Bathymetry given in Metres)

APPENDIX 7(b)

Sediment dispersion (turbidity) monitoing

OBJECTIVES OF SEDIMENT DISPERSION (TURBIDITY) MONITORING

(1) Minimize potential environmental impacts by ensuring that the sediment concentration levels surrounding the dredges and dump sites were within the compliance levels set by the Department of Fisheries and Oceans and Environment Canada.

(2) Assess the turbidity produced by dredging activities in relation to the natural turbidity generated by the flow conditions (tidal area, density flows) and storm related events.

(3) Ensure that the dredging turbidity levels entering the lake were less than 10 mg/L above background and within the natural turbidity variability occurring during fair weather conditions.

SUMMARY OF TURBIDITY DATA COLLECTED

MIDDLE SHOAL ENVIRONMENTAL MONITORING
BOTTOM MOUNTED OPTICAL BACK SCATTERANCE (OBS) INSTRUMENT LOCATIONS
MONITORING PERIOD: JULY 25 - NOVEMBER 15, 1996

SITE/DATE	LOCATION	DEPTH	INSTRUMENTATION	DATA ACQUIRED
SITE B-1 Aug 13 - Oct 9 Oct 22 - Nov 15	46°18.63'N 60°22.68'W (300 metres SE of Dump Site #B and 700 m from Dredging Operation)	5m	Bottom Mounted OBS Cyclops I Continuous Sampling 60 sec intervals	Sediment Trap and Obs Readings
SITE B-2 Aug 13 - Sept 16 Oct 9 - Oct 22	46°18.11'N 60°23.63'W (1.3 km SW of Dump Site #B and 300 metres from Dredging Operation)	6m	Bottom Mounted OBS Cyclops II Continuous Sampling 60 sec intervals	Sediment Trap and Obs Readings
SITE B-3 Sept 17 -Sept 25	46°19.0'N 60°23.8'W (400 metres NW of Dredging Operation)	11m	Bottom Mounted OBS Cyclops II Continuous Sampling 60 sec intervals	Sediment Trap and Obs Readings (Mooring Line Cut by Tug)
SITE B-4 Sept 27 - Oct 9	46°16.83'N 60°22.6'W (Duffus Point)	5m	Bottom Mounted OBS Cyclops II Continuous Sampling at 60 sec intervals	Sediment Trap and Obs Readings

SURFACE MOUNTED OPTICAL BACK SCATTERANCE (OBS) INSTRUMENT LOCATIONS

SITE/DATE	LOCATION	DEPTH	INSTRUMENTATION	DATA ACQUIRED
SITE S-1 Aug 28 - Aug 29	On I.V No. 8 Dredger 46°19.0'N 60°23.4'W	0.6m Below Surface	**Surface Mounted OBS Cyclops** Continuous Sampling at 24 sec intervals	**OBS Readings**
SITE S-2 Sept 11	On I.V No. 8 Dredger 46°18.8'N 60°23.5'W	0.6m Below Surface	**Surface Mounted OBS Cyclops** Continuous Sampling at 24 sec intervals	**OBS Readings** (Dredging Shutdown - High Winds)
SITE S-3 Sept 17 - Sept 18	On Rosaire Dredger 46°18.35'N 60°24.0'.	0.6m Below Surface	**Surface Mounted OBS Cyclops** Continuous Sampling at 24 sec intervals	**OBS Readings**
SITE S-4 Oct 22 - Nov 15	46°16.83'N 60°25.6'W (Duffus Point)	0.5m Below Surface	**Surface Mounted OBS Cyclops** Continuous Sampling at 60 sec intervals	**Sediment Trap and OBS Readings**

OBS PROFILE STATIONS

SITE/DATE	LOCATION	DEPTH	INSTRUMENTATION	DATA ACQUIRED
Region I/Variable Aug 20 - Oct 15	Nearfield Dredging Operation	Variable 5-13m	OBS Cyclops and CTD-OBS Sampling every 2 sec	OBS Profiles
Region II/Variable Aug 20 - Oct 10	Nearfield Dump Sites A & B	Variable 5-33 m	CTD-OBS Sampling every 2 sec	OBS Profiles
Region III/Variable July 25 - Oct 10	Farfield Bras D'Or Lakes, Bird Island, Middle Shoal	Variable 4-35 m	CTD-OBS Sampling every 2 sec	OBS Profiles

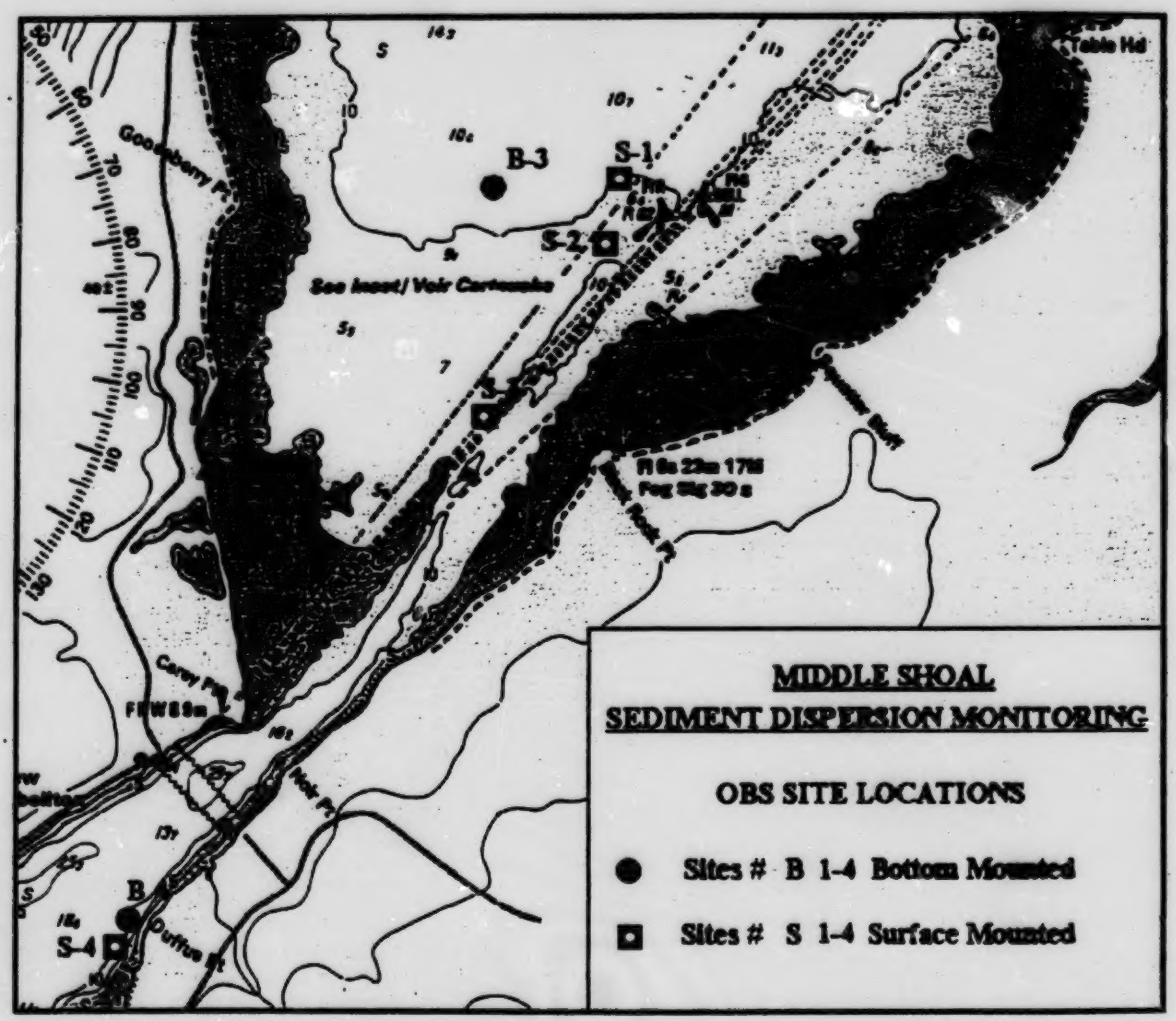


Table Hd
Gooseberry Pt
B-3
S-1
S-2
See Inset/Voir Cartouche
S-3
Fl 6s 23m 17M
Fog Sig 30 s
Carey Pt
Noir Pt
B
S-4
Duffus Pt
MIDDLE SHOAL
SEDIMENT DISPERSION MONITORING
OBS SITE LOCATIONS
● Sites # B 1-4 Bottom Mounted
▫ Sites # S 1-4 Surface Mounted

FIGURE 3.1. Location Map of Surface and Bottom Mounted OBS Site Locations

DISPERSION OF SEDIMENT AT DUMP SITES A AND B BASED ON SETTLING VELOCITY AND MATERIAL CLASSIFICATION

Site:	**DUMP SITE A**		**DUMP SITE B**	
Location:	**Lat: 46°21.6'N Long: 60°22.1'W**		**Lat: 46°18.8'N Long: 60°23.0'W**	
Currents: (Peak Tidal)	**10 to 15 cm/sec**		**10 to 15 cm/sec**	
Percentage (%) of Scow Discharge on Seabed	**Settling Time (min)**	**Dispersion Distance (Metres)**	**Settling Time (min)**	**Dispersion Distance Metres)**
88%	**3 min**	**18 to 27 m**	**1.2 min**	**8-11 m**
95%	**6.4 min**	**39-58 m**	**2.6 min**	**16-24 m**
98%	**18.8 min**	**115-170 m**	**7.6 min**	**46-68 m**
99.5	**45.0 min**	**270-405 m**	**18.3 min**	**110-170 m**

VERTICALLY-AVERAGED SUSPENDED SEDIMENT CONCENTRATIONS FOR VARIOUS SCOW DISCHARGES AT DUMP SITES A AND B

Site/ Date	Scow Quantity(yd^3)	Vertically-Averaged Suspended Sediment Concentration (mg/L)			
		Time After Scow Discharge			
		2 Minutes	5 Minutes	10 Minutes	15 Minutes
Site A 08/20/96	225	47	20	8	8
Site A 08/20/96	1000	88	36	-	9
Site A 08/21/96	1000	102	-	21	11
Site A 08/21/96	550	64	23	16	7
Site A 08/28/96	1225	83	15	31	8
Site A 08/28/96	1000	78	40	18	9
Site B 09/11/96	550	70	45	32	5
Site B 09/11/96	500	45	28	12	14
Site B 09/11/96	1000	97	48	19	8

VERTICALLY-AVERAGED AND MAXIMUM TURBIDITY LEVELS DOWNSTREAM OF DREDGERS (OBS PROFILE MEASUREMENTS)

Date	Downstream Distance				
	100m	200m	400m	600m	800m
08/20/96	7(12)	7(9)	6(9)	6(8)	-
08/20/96	8(14)	6(9)	-	-	6(8)
08/21/ 96	6(11)	7(12)	6(8)	6(8)	-
08/21/96	-	8(11)	8(12)	7(9)	-
08/21/96	9(14)	-	7(9)	-	8(9)
08/21/96	9(13)	-	8(10)	-	7(11)
08/28/96	9(16)		7(11)	-	-
08/29/96	10(18)	10(13)	-	-	6(7)
08/30/96	10(16)	12(18)	-	9(11)	-
09/11/96	8(12)	5(13)	5(7)	-	-
09/17/96	14(19)	9(16)	7(9)	-	6(7)
09/17/96	11(22)	14(17)	10(13)	-	6(10)
09/18/96	9(15)	9(13)	6(8)	-	-
09/25/96	7(18)	10(12)	8(11)	-	8(10)
10/08/96	12(16)		8(12)	-	-
Compliance Levels (mg/L)	-	200 mg/L	50 mg/L	25 mg/L	20 mg/L

Note: Maximum suspended sediment concentration in water column given in brackets.

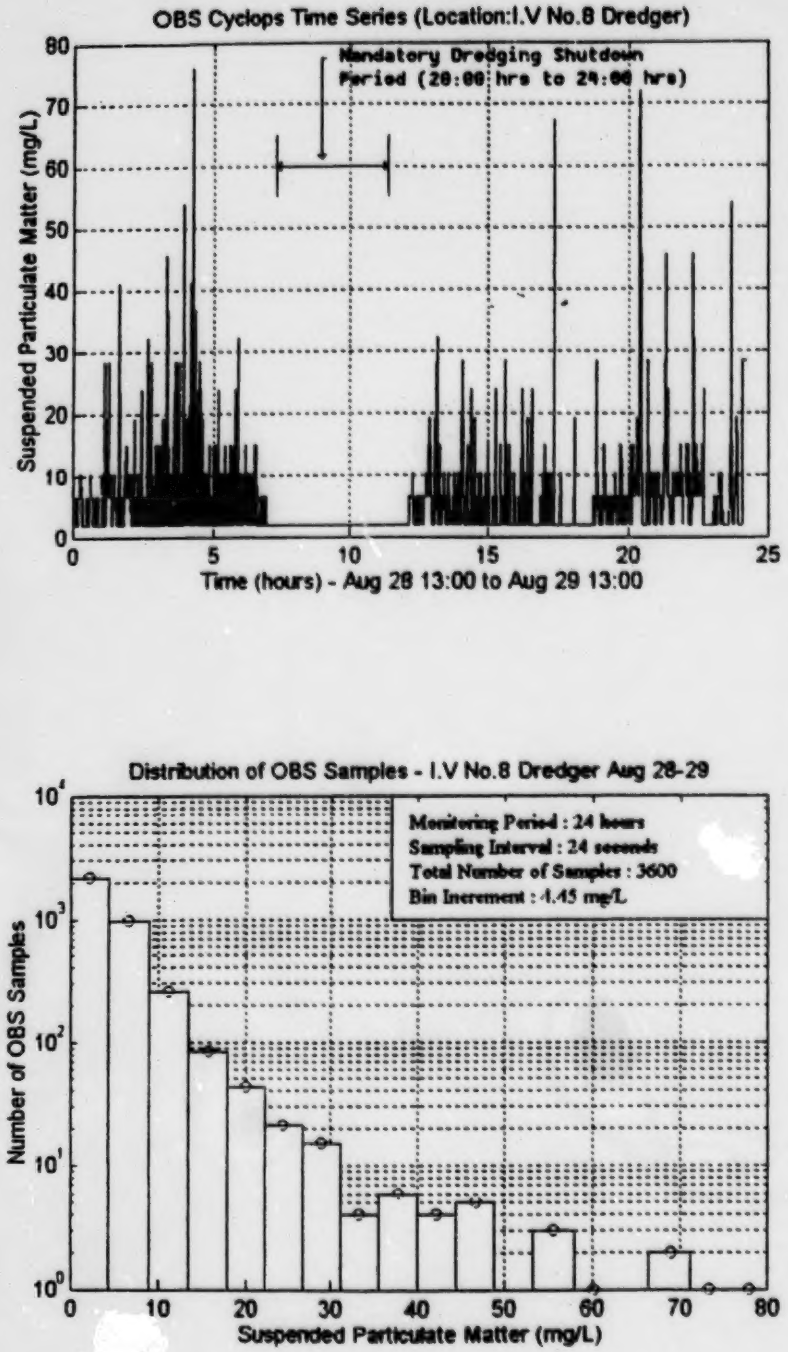
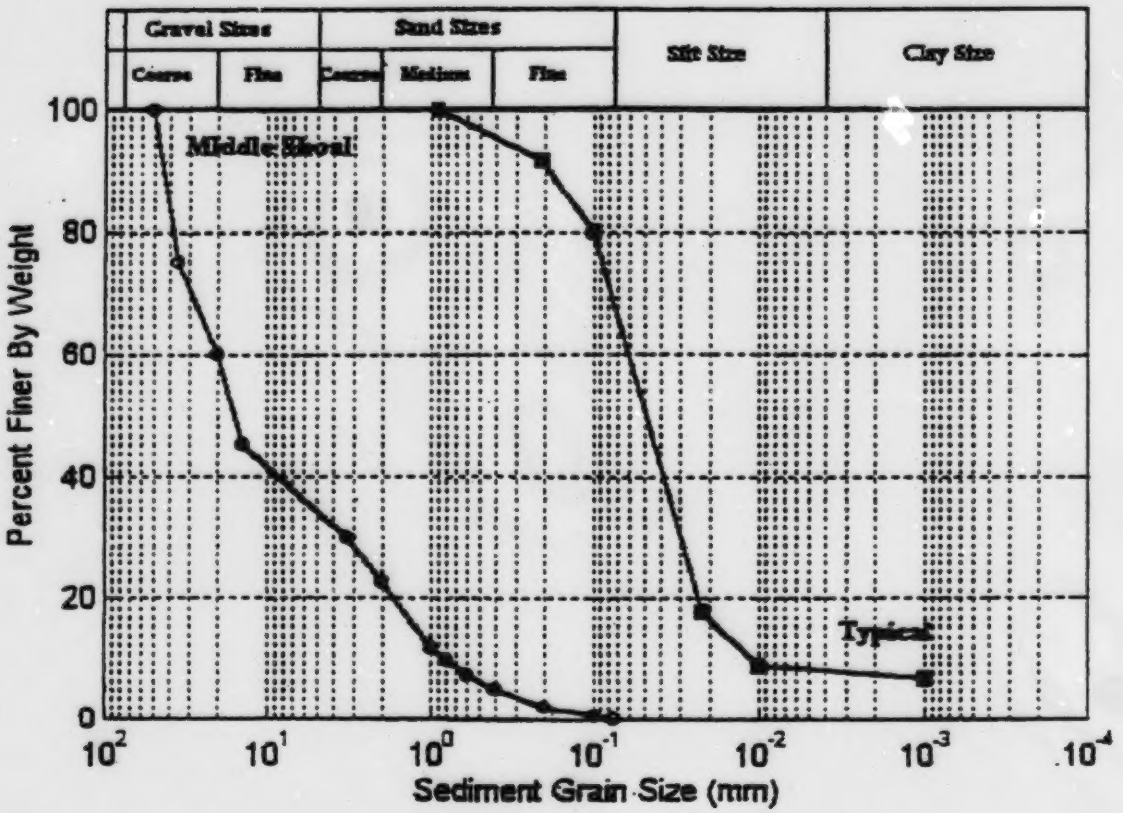


FIGURE 3.3. 24 Hour OBS Sampling at Site S-1
(On I.V. No. 8 Dredger - August 28 - 29)

ESTIMATION OF MASS TRANSPORT

- Based on point measurement of 5 mg/l (above background) at surface behind dredge (downstream of bucket)
- Assume concentration covers a cross section 10 m wide x 10 m deep
- Know flow rate across that area during 6.75 hrs of flood
- Know mass flow rate of sediment through that area
- Total quantity of sediment generated by dredging operation through that area is 3 to 4 m^3 during the entire flood tide



Grain Size Distributions from Two Distinct Dredging Environments - Middle Shoal and a Typical Harbour Environment in Eastern Nova Scotia

NATURAL SEDIMENT LOAD ESTIMATES INTO THE BRAS D'OR LAKES

Total Sedimentation Load (m^3) During 6.75 hrs of Flood Flow			
Turbidity (mg/L)		Large Tidal Range $Q = 125{,}315{,}100\ m^3$	Small Tidal Range $Q=96{,}435{,}100\ m^3$
Fair Weather Conditions	4	189	130
	8	378	260
	12	567	390
Storm Conditions*	20	945	650
	30	1418	975

*Additional wind induced flows not included in calculations.

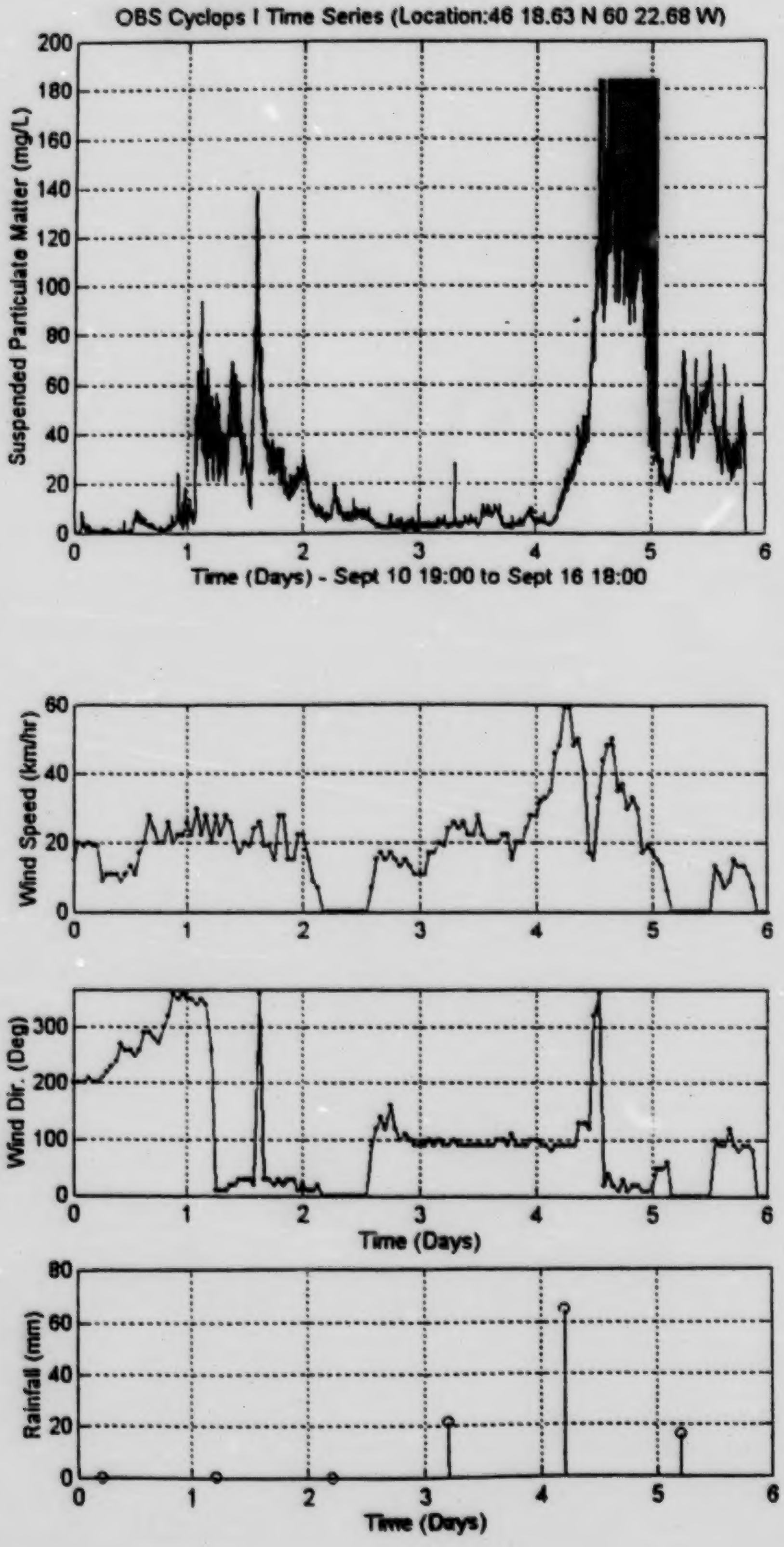

OBS Cyclops I Time Series (Location:46 18.63 N 60 22.68 W)
Suspended Particulate Matter (mg/L)
0
20
40
60
80
100
120
140
160
180
200
Time (Days) - Sept 10 19:00 to Sept 16 18:00
0
1
2
3
4
5
6
Wind Speed (km/hr)
0
20
40
60
Wind Dir. (Deg)
0
100
200
300
Time (Days)
Rainfall (mm)
0
20
40
60
80
Time (Days)

FIGURE C.7

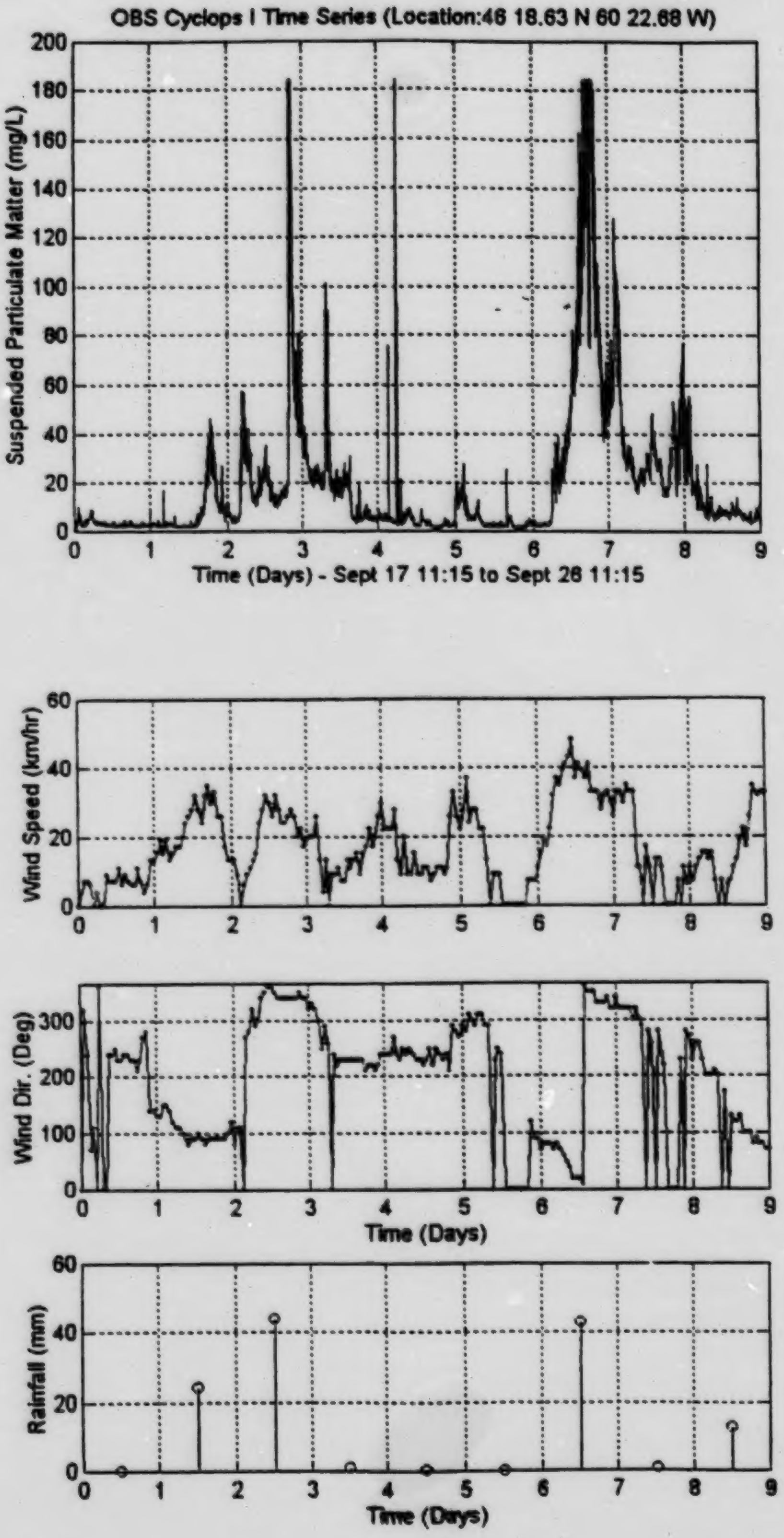

OBS Cyclops I Time Series (Location:46 18.63 N 60 22.68 W)
Suspended Particulate Matter (mg/L)
0
20
40
60
80
100
120
140
160
180
200
0
1
2
3
4
5
6
7
8
9
Time (Days) - Sept 17 11:15 to Sept 26 11:15
Wind Speed (km/hr)
0
20
40
60
Wind Dir. (Deg)
0
100
200
300
Time (Days)
Rainfall (mm)
0
20
40
60
Time (Days)

FIGURE C.9

APPENDIX 7(c)

Memo - December 12, 1996, T.G. Milligan (DFO) to H.B. Nicholls re. sediment dispersion (turbidity)

Government of Canada Gouvernement du Canada

MEMORANDUM NOTE DE SERVICE

To
À
Brian Nichols
Environmental Assessment Section
Marine Environmental Sciences Division
Science Branch

From
De
T.G. Milligan
Habitat Ecology Section
Marine Environmental Sciences Division
Science Branch

Security Classification - Classification de sécurité	
Our File - Notre référence	
Your File - Votre référence	
Date	December 12, 1996

Subject
Objet
Middle Shoal Channel Improvement Project

I had a chance to go over the documents you gave me last night. As far as the sediments in this operation are concerned, there does not appear to be a problem. If there were significant concentrations of fines associated with the dredge spoil, the most obvious place to find them would be draining from the dredge bucket as it leaves the water, and they would persist as a cloud around the working dredge. They would also be prominent during dumping of the spoil. Certainly the size distributions which I found in the documents indicate that there is a very low percentage of fines present. It is my understanding of the reports you gave me that fine sediment is not expected to be encountered during this project. The OBS data also indicate that there has been very little elevation in SPM as a result of dredging. Based on the observations noted in the reports, it would appear that the observed values are less than those caused by natural resuspension and erosion. I was glad to see in the consultants plan that they were going to carry out calibration of the OBSs using samples collected from the water column. Certainly Terry Sutherland is aware of the limitations of using OBSs and it appears that they have taken them into account in the monitoring proposal. Using them as described would show if SPM concentrations are increasing.

I noted in one of the consultant reports a statement that a sediment concentration as low as 10 mg l^{-1} can kill scallops. Although this statement is un-referenced, I suspect that they are referring to the work by Peter Cranford on the sensitivity of scallops to drilling waste. The results of Peter's work on the sub-lethal effects of long term exposures of scallops to bentonite, barite and oil-based drilling muds would not apply to natural sediment. Recent work with natural sediments from Georges Bank has indicated that increased seston concentrations can be beneficial to scallop growth (Grant et al., in press). Considering the concentrations of SPM indicated by the OBS surveys, I think it unlikely that the concentrations of fine particles in the benthic boundary layer will exceed natural levels.

I am sorry I will be away during next week's meeting. However, if any questions are asked about the fate of the fine particles I would be more than happy to field them on my return.

Tim Milligan.

Copy: P.D. Keizer

References:

Cranford, P.J. and D.C. Gordon, 1991, Chronic sublethal impact of mineral oil-based drilling mud cuttin on adult sea scallops, Mar. Poll. Bul., 22, 7, 339-344.

Cranford, P.J. and D.C. Gordon, 1992, The influence of dilute clay suspensions on sea scallop (*Placopecte Magellanicus*) feeding activity and tissue growth, Neth. J. Sea Res., 30, 107-120.

Grant, J., P.C. Cranford and C. Emerson, in press, Sediment resuspension rates, organic matter quality, an food utilization by sea scallops (*Placopecten Magellanicus*) on Georges Bank, J. Mar. Sci.

APPENDIX 8(a)

Fisheries monitoring program

FISHERIES MONITORING PROGRAM PRESENTATION

Presented By:

Mr. Norval Collins
CEF Consultants

The Fisheries Monitoring Program

- an overview of program components
- the fish migration surveys
    - calibration of fish finders
    - description of transects and training
    - results
- fish behaviour monitoring
- work area monitoring
- fish habitat stations
- underwater sound measurements
- conclusions

Component Objectives

- fish migration surveys

Element	Monitoring Description
Hypothesis:	Fish migrations in the Great Bras d'Or are not blocked by project activities.
Baseline:	Routine monitoring will estimate the numbers of fish moving in and out of the Great Bras d'Or. Changes in patterns as a result of project activities should be observed if the hypothesis is false. Results will provide a baseline for comparison with the tracking of individual fish or schools.
Measurements or Recording Format:	Numbers of individual fish and schools within depth intervals will be recorded at routine transect locations 3 times per day.
Compliance Criteria:	Delays of longer than 4 hours or the length of the daily shutdown period should not occur.
Individuals Responsible:	Conducted by trained fishermen assisted by onboard observers

Component Objectives

- fish behaviour monitoring

Element	**Monitoring Description**
Hypothesis:	Fish migrations in the Great Bras d'Or are not blocked by project activities.
Baseline:	Specific schools of mackerel [and herring] followed to determine natural movements and movements in response to project activities. Consistent attraction or avoidance of project activities should be observed if the hypothesis is false.
Measurements or Recording Format:	The behaviour of specific schools of fish will be tracked and positions noted in relation to project activities.
Compliance Criteria:	Delays of longer than 4 hours or the length of the daily shutdown period should not occur.
Individuals Responsible:	Conducted by trained fishermen assisted by onboard observers.

Component Objectives

- work area monitoring

Element	Monitoring Description
Hypothesis:	High densities of lobster and juvenile cod are not present in work areas.
Baseline:	Previous ROV surveys have not indicated high densities of commercially important species in any of the work areas.
Measurements or Recording Format:	Once correlations with trap and bottom trawl surveys have been developed, ROV surveys will be used to determine abundance of commercial species.
Compliance Criteria:	Catch not to exceed 0.3 lobster per trap in the perimeter of Site A Revised.
Individuals Responsible:	Cooperative venture by fishermen, DFO and project consultants.

Component Objectives

- fish habitat stations

Element	Monitoring Description
Hypothesis:	Sediment carried from project activities is not sufficient to degrade nearby fish habitat.
Baseline:	Habitat quality, in terms of macroepiflora and infauna, will be established at permanent transects prior to project activities beginning. Two control sites should also be established for comparison (to provide indications of changes due to season or storms).
Measurements or Recording Format:	Macroepiflora will be determined per square meter at permanent quadrates. Infauna will be determined from sediment samples collected by diver or grab along permanent transects.
Compliance Criteria:	Any visible degradation of important habitat areas will result in remedial action.
Individuals Responsible:	Conducted by biologist/diver.

Component Objectives

- underwater sound measurements
  - measured on September 30 using hydrophones calibrated from 300 Hz to 10 kHz.
  - sounds recorded digitally in ‘snapshots’ over short intervals.
  - measured over a frequency range of 100 Hz to 10 kHz.
  - measurements taken as all dredging equipment operated.
  - individual events were characterized as:
    - water falling from the bucket;
    - the bucket hitting the water's surface;
    - the bucket hitting the bottom of the sea bed; and
    - movement of the dredge barge 'spuds'.

Fish Migration Surveys

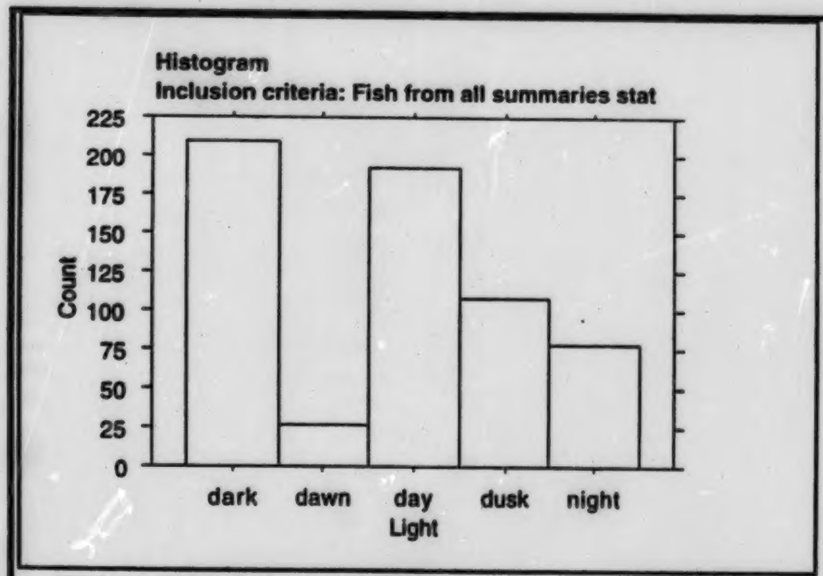
Number of Transect Runs by Line and Run Number

Line Name	Initial Runs	Duplicate Runs	Total Runs
Auld's Cove	132	75	207
Freddy's Cabin	123	78	201
Table Rock	130	77	207
Totals	385	230	615

Fish Migration Surveys

- day: covering the full daylight period;
- dusk: covering the twilight period after sunset;
- dark: covering the 8 pm to midnight period when dredging activities were generally shut down;
- night: covering the 1 am to 3 am period when dredging was generally active and in darkness; and
- dawn: covering the early morning twilight period before sunrise.

Fish Migration Surveys



Distribution of Light Conditions

- 10 percent of the runs occurred during slack tide, and the other runs were split evenly between flood and ebb tides.

Fish Migration Surveys

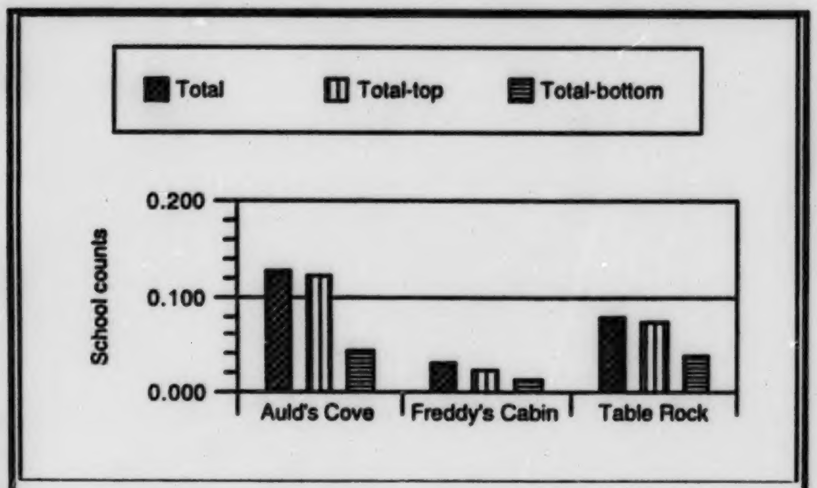
- monitoring data begins August 19
- dredging began August 20
- dredges stopped working October 24
- last two dredges left the area November 1
- monitoring continued until November 14

Fish Migration Surveys

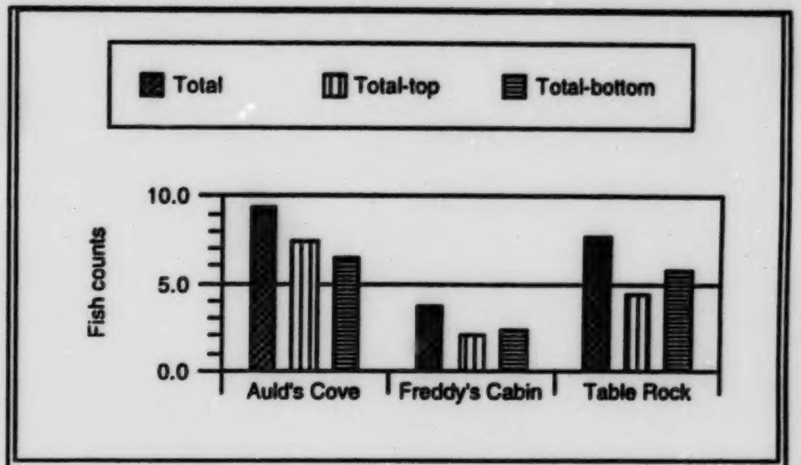
- analysis included:
  - surface or bottom counts;
  - duplicate runs;
  - differences between transect lines;
  - periods of the day and dredging active or inactive;
  - dredging quantities;
  - tidal conditions;
  - changes over time; and
  - variations from east to west.

Fish Migration Surveys

- comparison of surface, bottom and total counts



School counts adjusted for surface and bottom layers



Fish counts adjusted for surface and bottom layers

Fish Migration Surveys

- comparison of variance between duplicate runs

ANOVA Table for Total School Counts by Run and Transect Line

Variable	**DF**	**Sum of Square**	**Mean Square**	**F-Value**	**p-Value**
Transect Line	2	0.696	0.348	14.046	<0.0001
Subject (Runs)	225	5.58	0.025		
Within Runs	1	0.005	0.005	0.456	0.500
Within Runs between Lines	2	<0.001	<0.001	0.002	0.998
Residual	225	2.274	0.010		

Fish Migration Surveys

- comparison of variance between duplicate runs

ANOVA Table for Total Fish Counts by Run and Transect Line

Variable	**DF**	**Sum of Square**	**Mean Square**	**F-Value**	**p-Value**
Transect Line	2	1708.6	854.3	35.011	<0.0001
Subject (Runs)	225	5490.0	24.4		
Within Runs	1	8.171	8.171	3.53	0.062
Within Runs between Lines	2	1.904	0.952	0.411	0.663
Residual	225	520.74	2.314		

Fish Migration Surveys

- comparison of variance between lines

Table 3: ANOVA Table for Counts by Transect Line

Variable	**DF**	**Sum of Square**	**Residual Sum of Squares**	**F-Value**	**p-Value**
Individual fish	2, 612	.984	9.657	31.168	<0.0001
Schools	2, 612	2934.6	9077.0	98.928	<0.0001

Fish Migration Surveys

- comparison of variance between light conditions

ANOVA Table for Total School Counts by Line and Light

Variable	DF	Sum of Square	Mean Square	F-Value	p-Value
Transect Line	2	0.540	0.270	15.537	<0.0001
Light	4	0.057	0.014	0.824	0.5103
Line & Light	8	0.262	0.033	1.887	0.0594
Residual	600	10.422	0.017		

Fish Migration Surveys

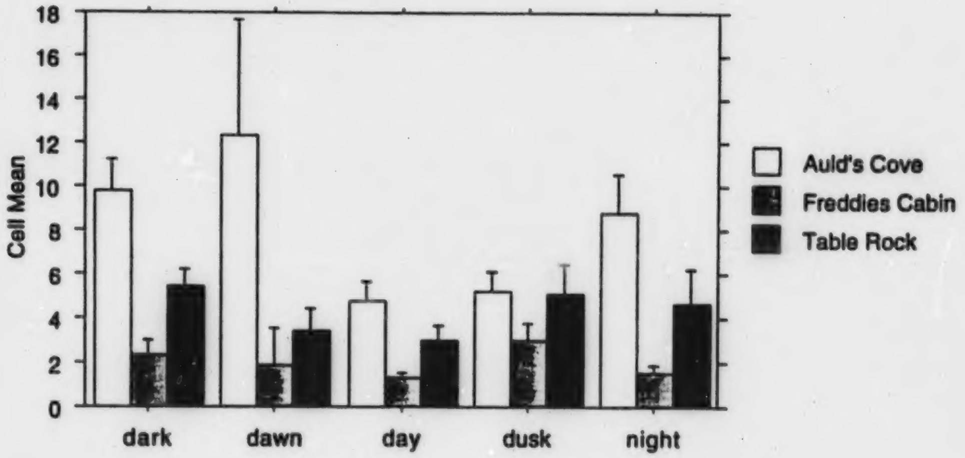
- comparison of variance between light conditions

ANOVA Table for Total Fish Counts by Line and Light

Variable	**DF**	**Sum of Square**	**Mean Square**	**F-Value**	**p-Value**
Transect Line	2	2332.0	1166.0	93.8	<0.0001
Light	4	867.7	216.9	17.5	<0.0001
Line & Light	8	736.6	92.1	7.4	<0.0001
Residual	600	7455.2	12.4		

Fish Migration Surveys

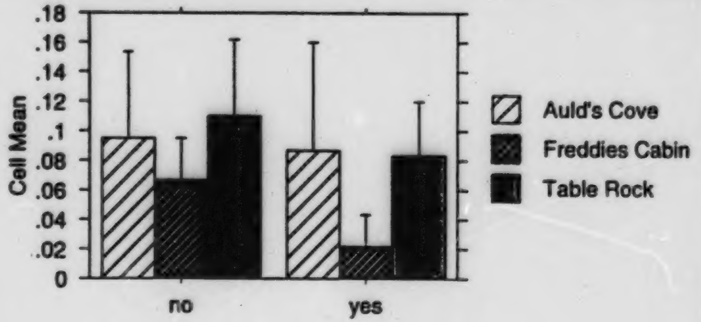
- comparison of variance between light conditions



Comparison of Fish Counts for Light Conditions by Line

Fish Migration Surveys

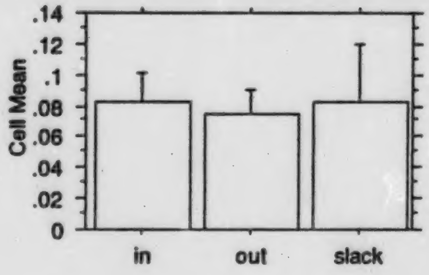
- effect of dredging
  - regression of daily dredged quantity was not significant for fish or school counts
  - variable for dredging 'yes' or 'no' applied mainly to the dark period when 4-hour shut downs occurred
  - 'yes' or 'no' was only significant for Freddy's Cabin, dark runs



School Counts when dredging by line

Fish Migration Surveys

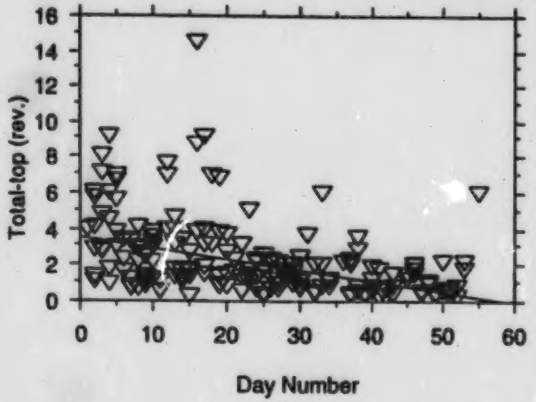
- effect of tide
  - tide conditions were well represented
  - tide was not a significant factor in counts of fish or schools



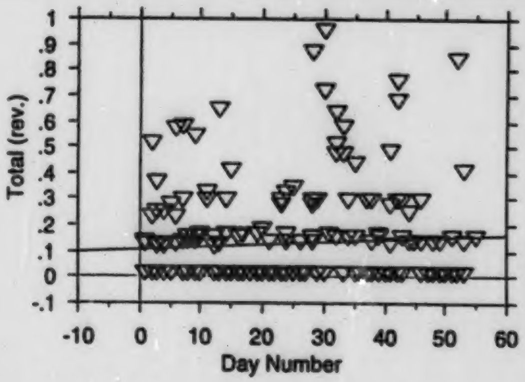
School counts by tide

Fish Migration Surveys

- changes over time
  - counts of fish were generally lower after September 22
  - school counts tended to increase throughout the project at Auld's Cove with a peak around October 8



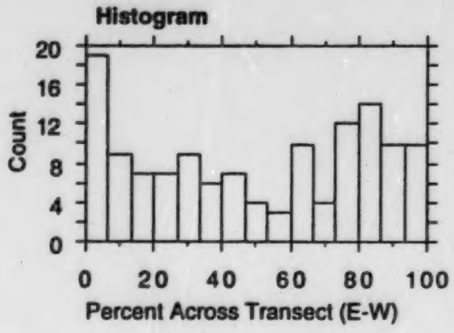
Fish counts by day number at Freddy's Cabin



School counts by day number at Auld's Cove

Fish Migration Surveys

- distribution of schools east to west
  - data collected between August 19 and September 28 was used
  - the location of a school was determined by the interval in which it was recorded
  - vessels ran from east to west and the time interval represented a percentage traveled across the transect



Locations of Schools at Table Rock

Fish Migration Surveys

- species identification

Summary of All Fish Species Caught

	Auld's Cove		**Table Rock**	
Species	**Juvenile**	**Adult**	**Juvenile**	**Adult**
Butter fish	30		3	
Mackerel	10	28		1
Smelt	8	11		4
Herring	29	36	17	
Red Hake	5		3	
Flounder	1			
Spiny Dogfish		1		
Sculpin		2		
Bill fish		1		
Gaspereau	9	2		

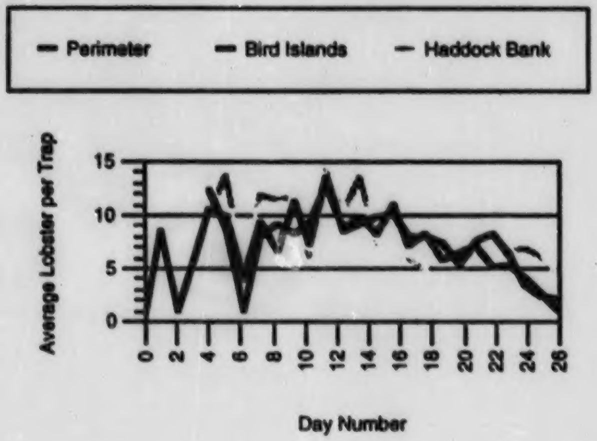
Work Area Monitoring

- general configuration of traps within the work areas

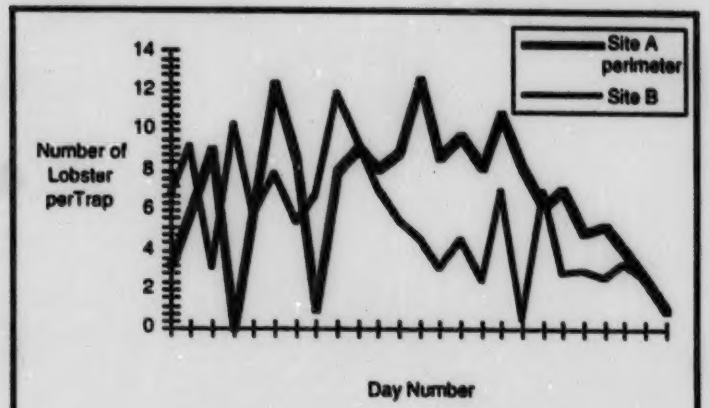
Date	Site A	Site B	Dredge Area
August 6	21 traps in 3 squares	9 in 2 parallel lines	30 in 4 squares
August 16	21 traps in 3 squares	No traps set	21 heavier traps replaced 30 smaller ones
August 30	12 in perimeter and 11 towards Bird Islands	9 in 2 parallel lines	21 in 3 squares
September 27	23 traps in perimeter and Bird Islands, 5 set in Haddock Bank	7 in 1 straight line	3 in 1 straight line
October 3	Same as above except 3 traps were set in the center of Site A	7 in 1 straight line	3 in 1 straight line

Work Area Monitoring

- lobster abundance in Site A and Site B



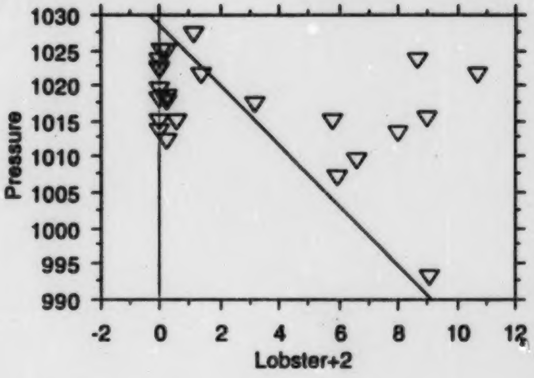
Lobster Abundance in Site A



Lobster Abundance in Site A and Site B

Work Area Monitoring

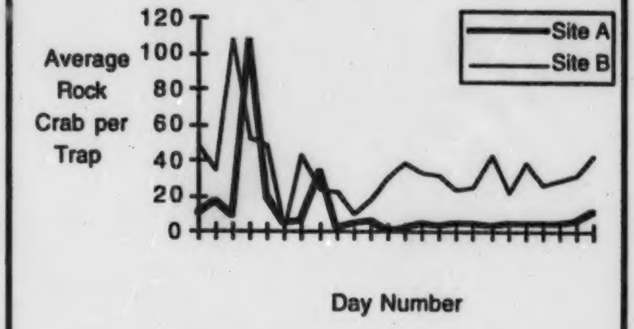
- lobster abundance was correlated with changes in barometric pressure at Site A
    - regression equating barometric pressure and lobster catch was significant (p=0.023) between August 6 and September 30
    - after September 30 lobster began to remain on the site



Barometric pressure (kPA) and lobster catch

Work Area Monitoring

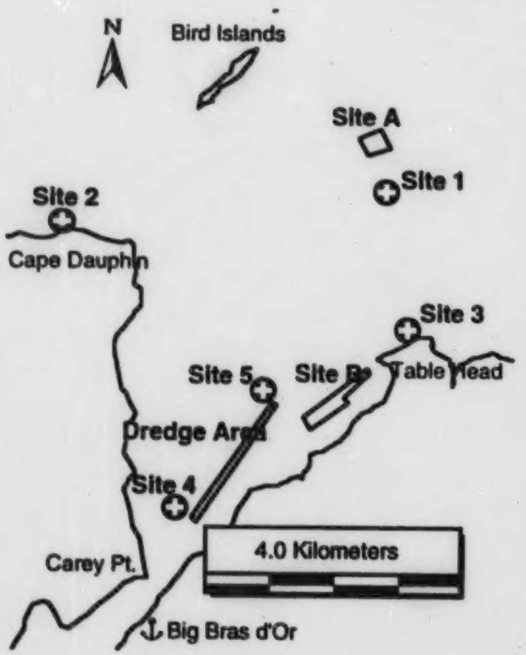
- rock crabs were also monitored
  - crabs in all areas generally had soft shells in August
  - most shells had hardened by mid-September
  - most commercial-sized crabs were on Site A and use of Site A stopped just as the marked opened



Rock Crab Counts

Fish Habitat Stations

- habitat stations were established August 28 and 29


N
Bird Islands
Site A
Site 1
Site 2
Cape Dauphin
Site 3
Site 5
Site B
Table Head
Dredge Area
Site 4
Carey Pt.
4.0 Kilometers
Big Bras d'Or

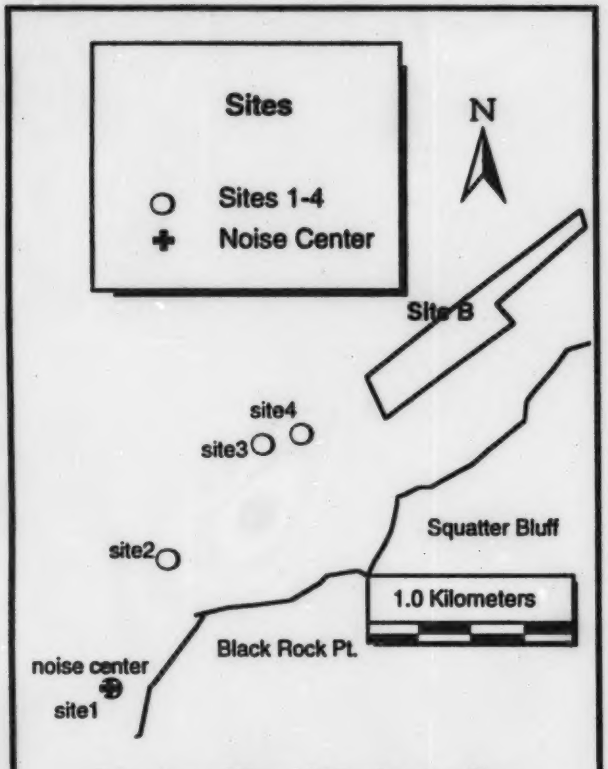
Location of Habitat Sites

Location and depths of the habitat sites are:

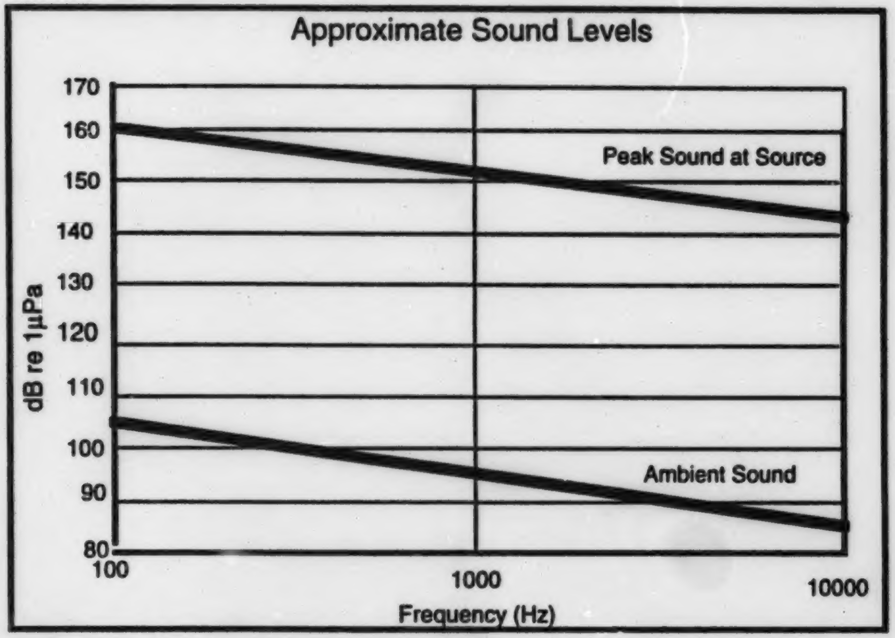
- **Site #1, Dive #1, Site A Revised** – Position 46° 21.226' N, 60° 21.982' W; Depth 29 m.
- **Site #2, Dive #2, Fairy Hole** – Position 46° 20.777' N, 60° 26.113' W; Depth 14 m.
- **Site #3, Dive #3, Table Rock** – Position 46° 19.751' N, 60° 21.547' W; Depth 7 m.
- **Site #4, Dive #4, Three Fathom Shoal** – Position 46° 18.188' N, 60° 24.392' W; Depth 10 m.
- **Site #5, Dive #5, Moose River** – Position 46° 19.240' N, 60° 23.505' W; Depth 14 m.

Underwater Sound Measurements

- noise measurements were taken at four different sites 70 to 1730 meters from the dredging activity

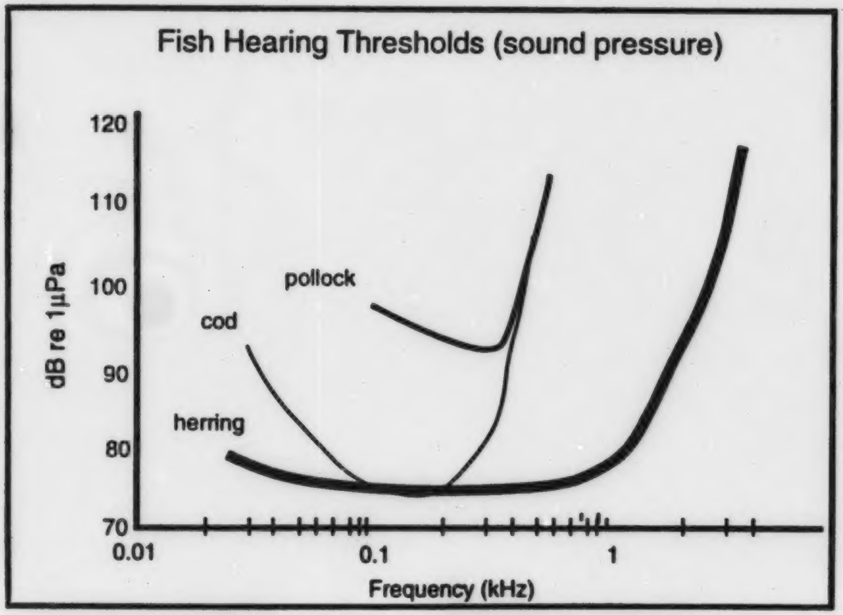

Sites
○ Sites 1-4
✚ Noise Center
N
Site B
site4
site3
site2
noise center
site1
Squatter Bluff
Black Rock Pt.
1.0 Kilometers

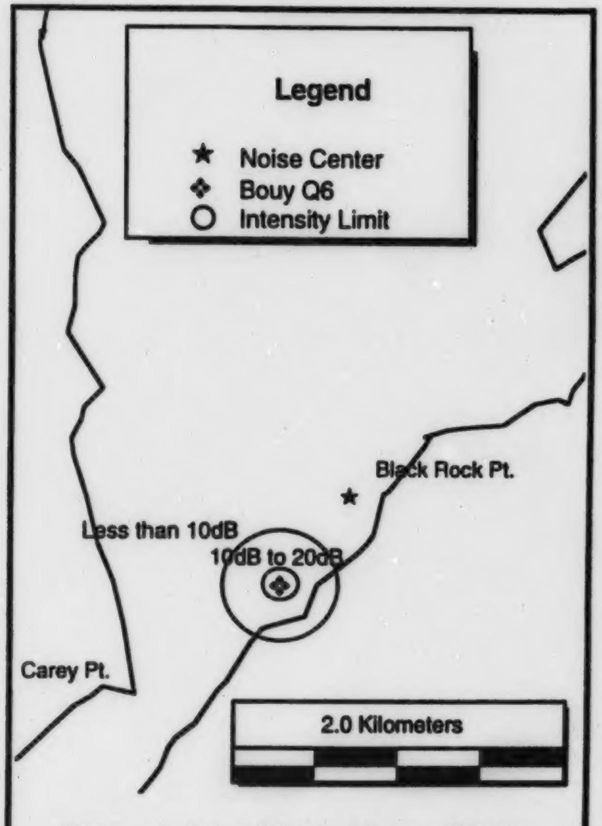
Location of Sound Monitoring Sites



Underwater Sound Measurements

- herring are relative sensitive to noise and would not likely react to sound levels less than 20 dB above ambient


Fish Hearing Thresholds (sound pressure)


Legend
★ Noise Center
✥ Bouy Q6
○ Intensity Limit
Black Rock Pt.
Less than 10dB
10dB to 20dB
Carey Pt.
2.0 Kilometers

Distance of Possible Avoidance of Noise

Conclusions

- physical monitoring indicated suspended sediment levels averaged 4.6 mg/L
- most fish are unlikely to avoid suspended sediment levels of less than 10 mg/L
- the higher counts at Freddy's Cabin during dark and 'no' dredging is one of the few indicators of avoidance
- almost all behaviour studies indicate attraction at low levels, if any response
- no change in numbers was observed at Auld's Cove following the end of dredging or the dredges leaving the harbour
- the evidence suggests minimal if any effect of dredging operations on migrating fish

Conclusions

- the low level of sedimentation suggests that habitat stations do not need to be re-occupied
- disposal or habitat creation areas should be re-surveyed annually for two years to document colonization

APPENDIX 8(b)

Fisheries monitoring program, fish migration surveys, calibration of fish finders

FISHERIES MONITORING PROGRAM PRESENTATION

contd.

Presented By:

Mr. Shawn Martin
CEF Consultants

Reasons for Calibration:

1) Different sounder models
2) Different vessels
3) Sensitvity too high
4) Change over time

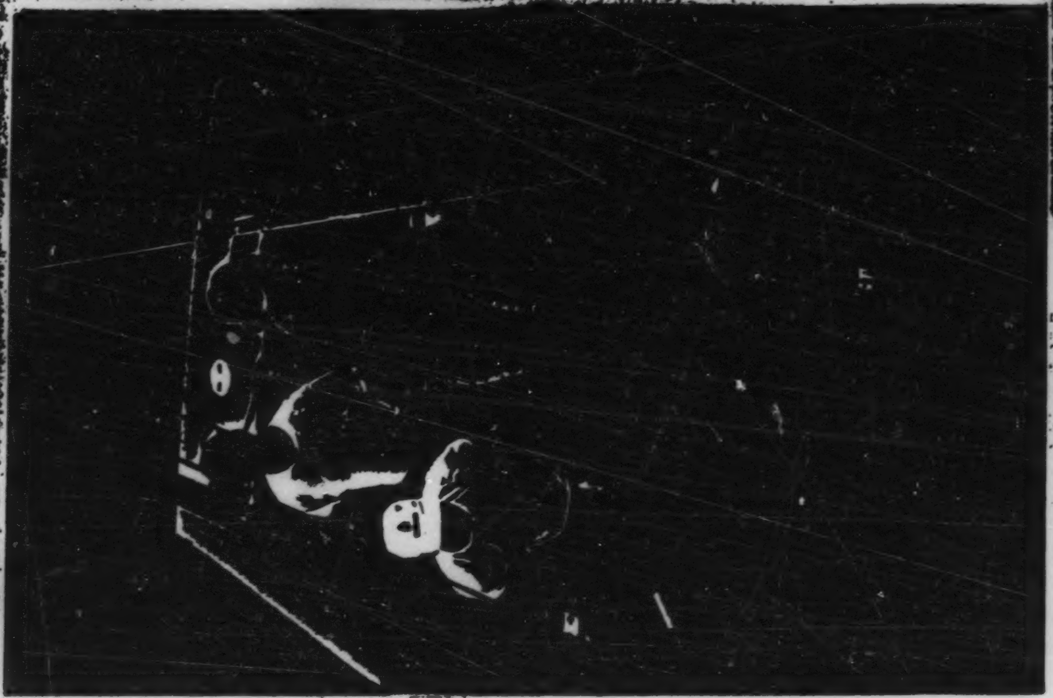
Table 2: Target Strengths based on Light Bulb Diameter

Target Size	Diameter (m)	Target Strength (dB)
Small	0.047	-46
Medium	0.060	-43
Large	0.095	-39

For Cod:	Target Strength (in dB) = 20 log (length in cm) - 67.5
For Herring:	Target Strength (in dB) = 20 log (length in cm) - 71.9
For Mackerel:	Target Strength (in dB) = 20 log (length in cm) - 81.9

Table 3: Length of Fish Represented by Calibration Targets

	Length of Fish Species (cm)		
Target Size	Cod	Herring	Mackerel
Small	12	20	62
Medium	17	28	
Large	27	44	



APPENDIX 8(c)

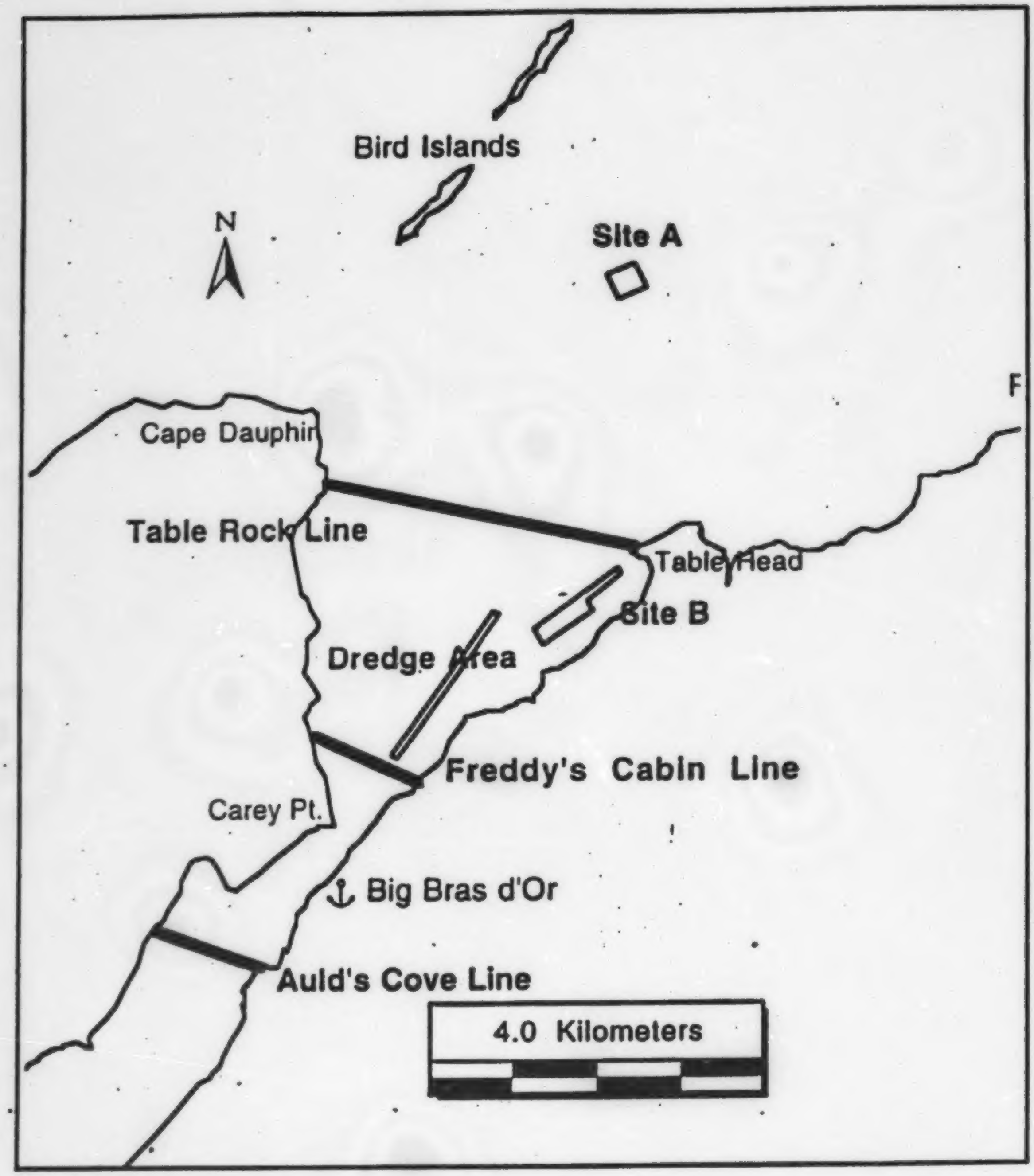
Fisheries monitoring program, fish migration surveys, transects and data

FISHERIES MONITORING PROGRAM PRESENTATION

contd.

Presented By:

Ms. Laura Imlay
CEF Consultants


Bird Islands
N
Site A
F
Cape Dauphin
Table Rock Line
Table Head
Site B
Dredge Area
Freddy's Cabin Line
Carey Pt.
Big Bras d'Or
Auld's Cove Line
4.0 Kilometers

Fish Finder Recording Sheet - Middle Shoal Improvement Project

Date: Oct 3/96 Transect Location: Auld's Cove Run: 2

Start Time: 20:39 Course: 326° Mag Gain: 2.8 dusk/[✓ dark]/night tide in/out/[✓ slack] Sheet 1

Size: S=small, M=medium, L=large School Size: S=to 5', M=5-15', L=>15'

TIME	0 - 0.5		0.5 - 1.0		1.0 - 1.5		1.5 - 2.0		2.0 - 2.5	
Depth Range	Fish	Schools	Fish	Schools	Fish	Schools	Fish	Schools	Fish	Schools
0 - 2 Fathoms							1s		1L1s	
2 - 5 Fathoms			2L1m1s		1s					
Middle										
5 to 1 Fathom up					1L					
Bottom up to 1 Fathom	1L				1m					
Depth (fathoms)	2		6		10		11		12	

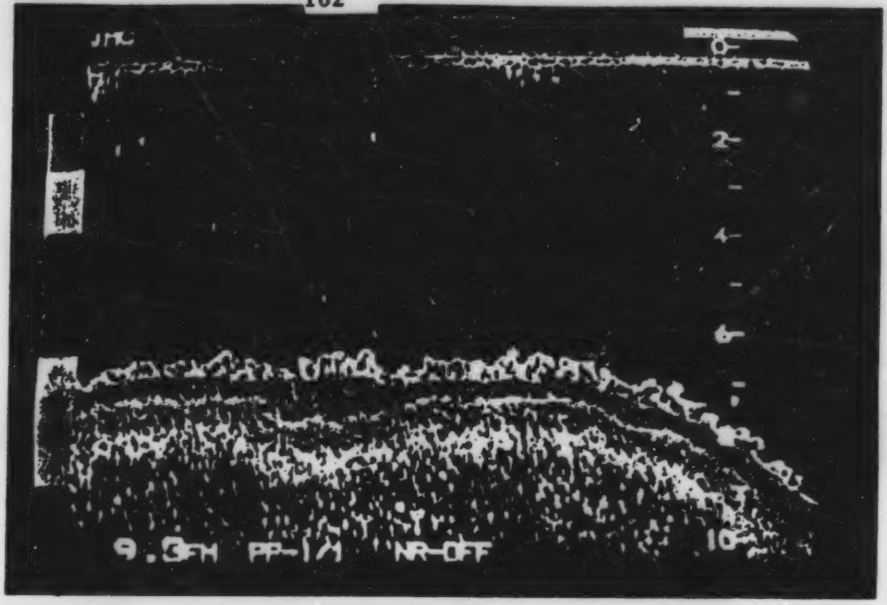
TIME (minutes)	2.5 - 3.0		3.0 - 3.5		3.5 - 4.0		4.0 - 4.5		4.5 - 5.0	
Depth Range	Fish	Schools	Fish	Schools	Fish	Schools	Fish	Schools	Fish	Schools
0 - 2 Fathoms	3s3L				(3L2s)					
2 - 5 Fathoms					1s					
Middle										
5 to 1 Fathom up	1s									
Bottom up to 1 Fathom					1L		2L			
Depth (fathoms)	12		10		9		8		7	

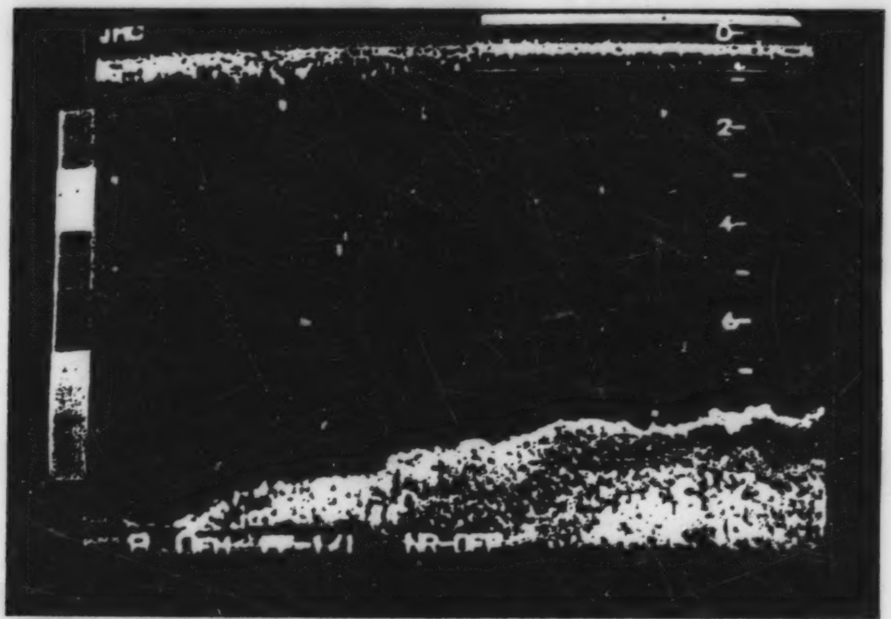
TIME (minutes)	5.0 - 5.5		5.5 - 6.0		6.0 - 6.5		6.5 - 7.0		7.0 - 7.5	
Depth Range	Fish	Schools	Fish	Schools	Fish	Schools	Fish	Schools	Fish	Schools
0 - 2 Fathoms							1s			
2 - 5 Fathoms	1L									
Middle										
5 to 1 Fathom up										
Bottom up to 1 Fathom					1L					
Depth (fathoms)	6		6		5		5		7	

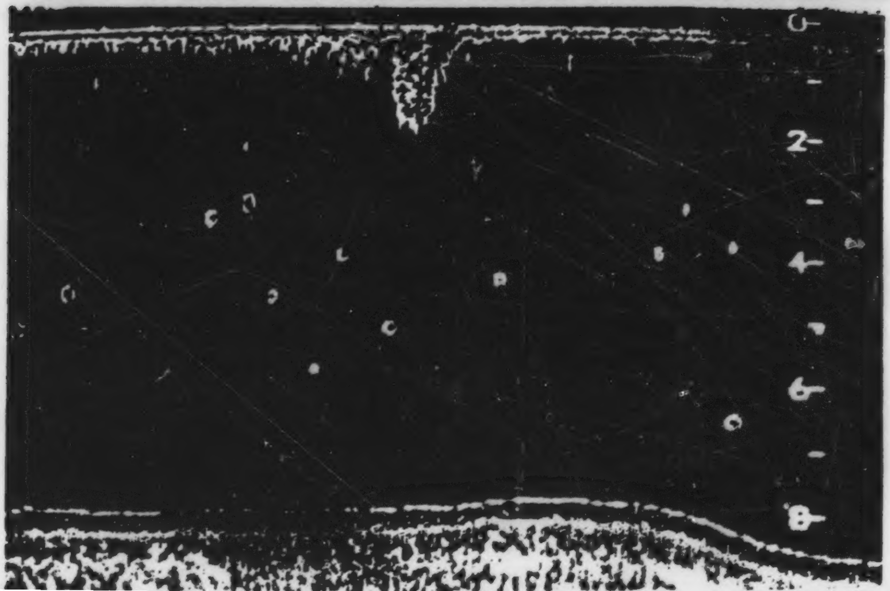
TIME (minutes)	7.5 - 8.0		8.0 - 8.5		8.5 - 9.0		9.0 - 9.5		9.5 - 10.0	
Depth Range	Fish	Schools	Fish	Schools	Fish	Schools	Fish	Schools	Fish	Schools
0 - 2 Fathoms	1s									
2 - 5 Fathoms										
Middle										
5 to 1 Fathom up										
Bottom up to 1 Fathom	1L									
Depth (fathoms)	6		5							

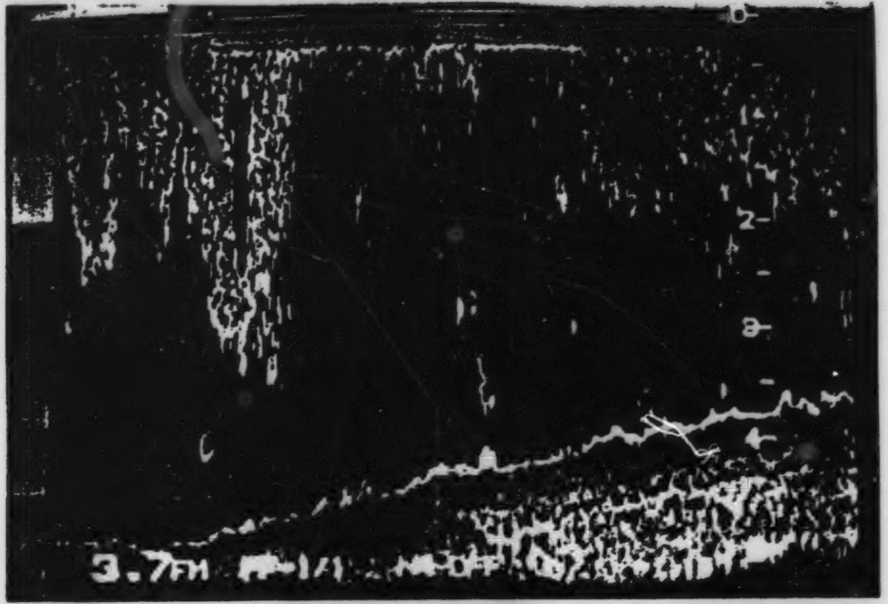
Minutes: ____ # Fish: 32 # Schools: 0

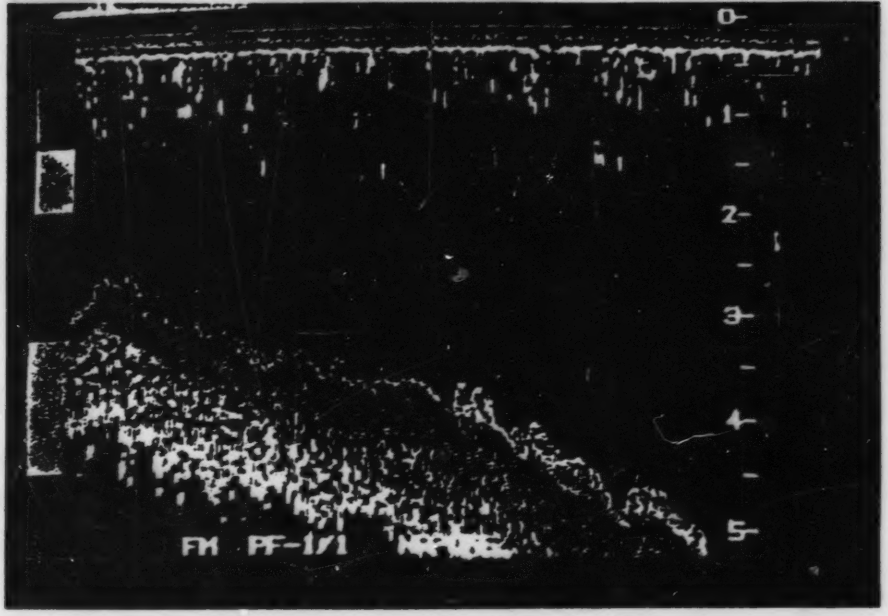
CEF

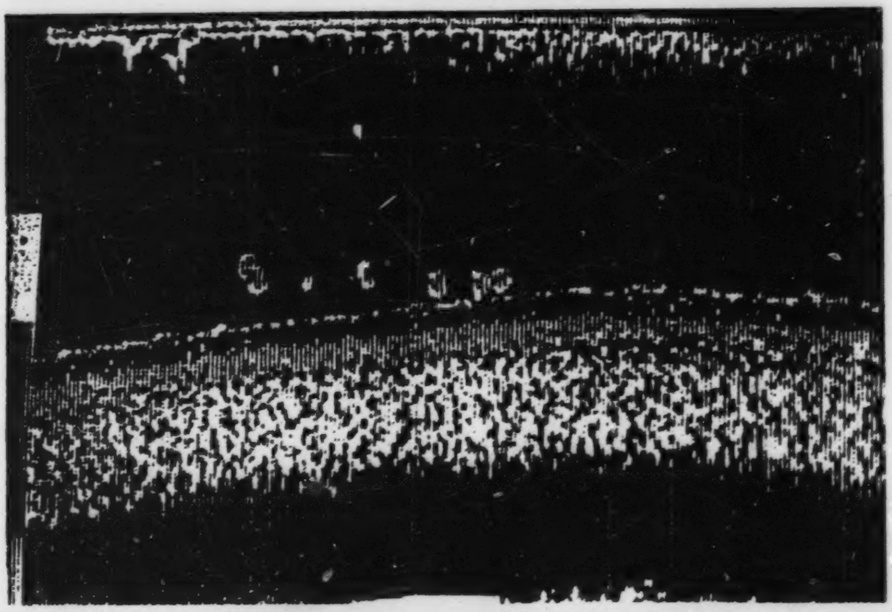

JMC
0
2
4
6
10
9.3FM PP-1/1 NR-OFF


JMC
0
2
4
6
8.0FM PP-1/1 NR-OFF


0
2
4
6
8


0
2
3
4
3.7FM


0
1
2
3
4
5
FM PF-1/1



APPENDIX 8(d)

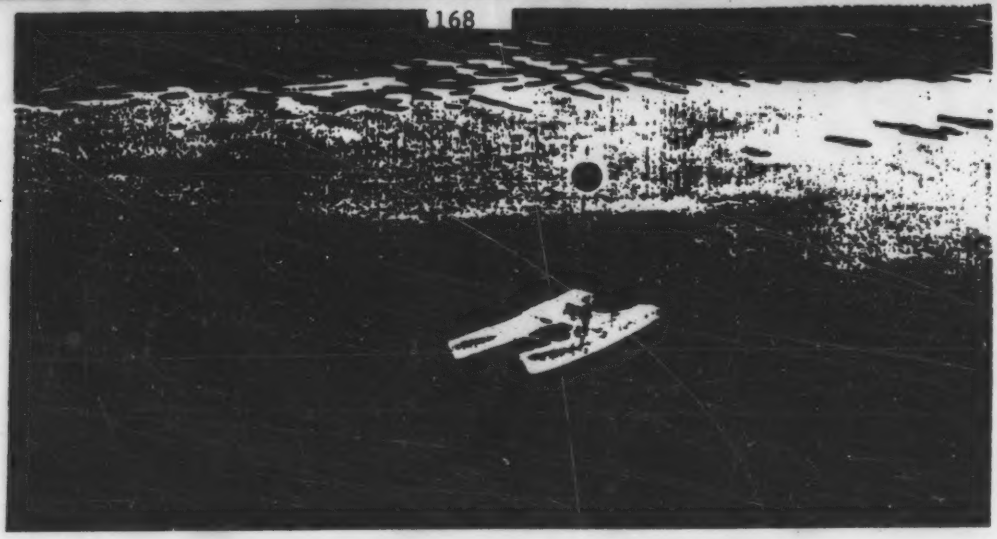
Fisheries monitoring program, fish behaviour monitoring

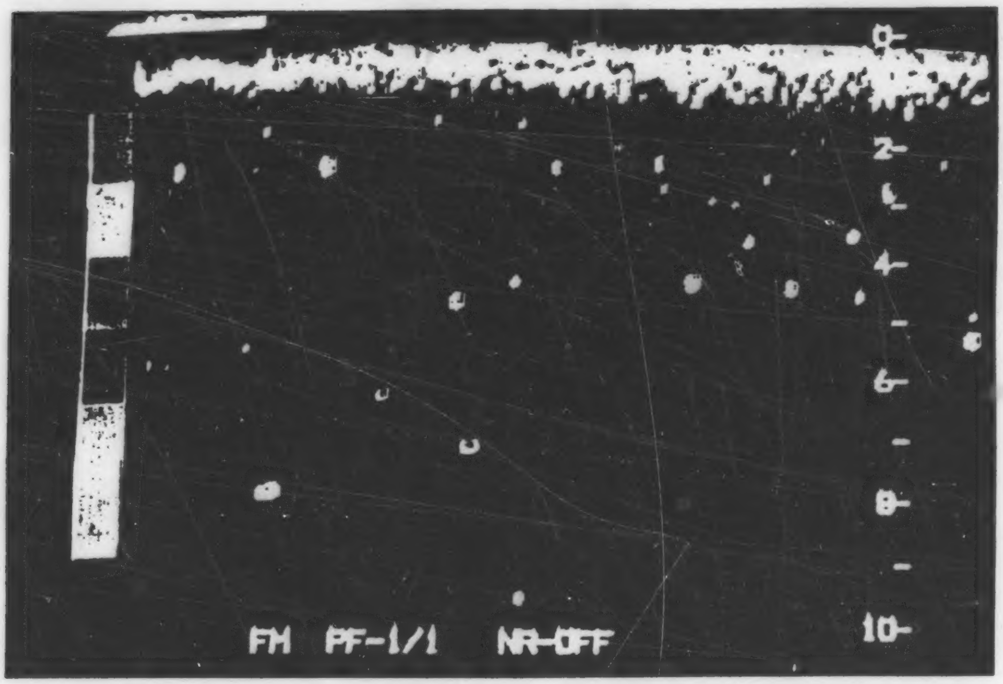
FISHERIES MONITORING PROGRAM PRESENTATION

contd.

Presented By:

Mr. Mark Biagi
CEF Consultants




0
2
4
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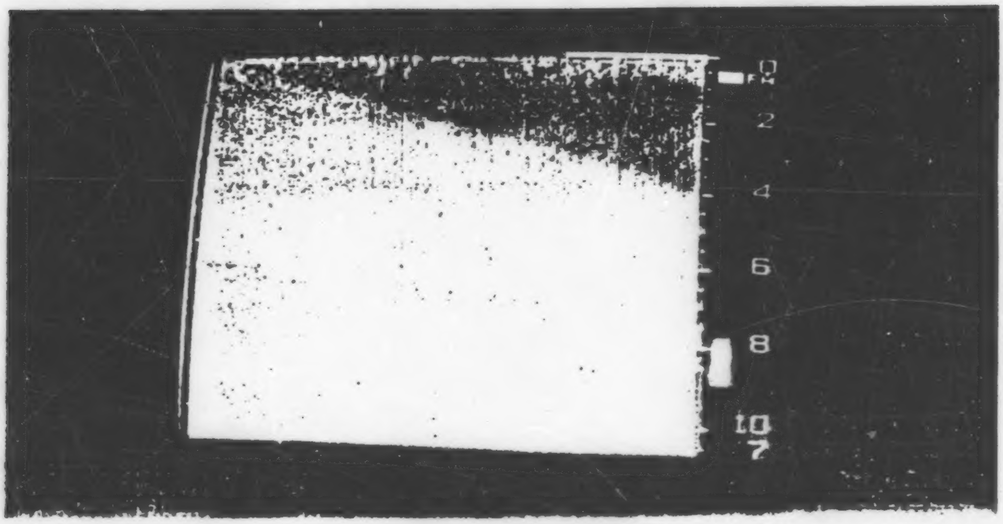
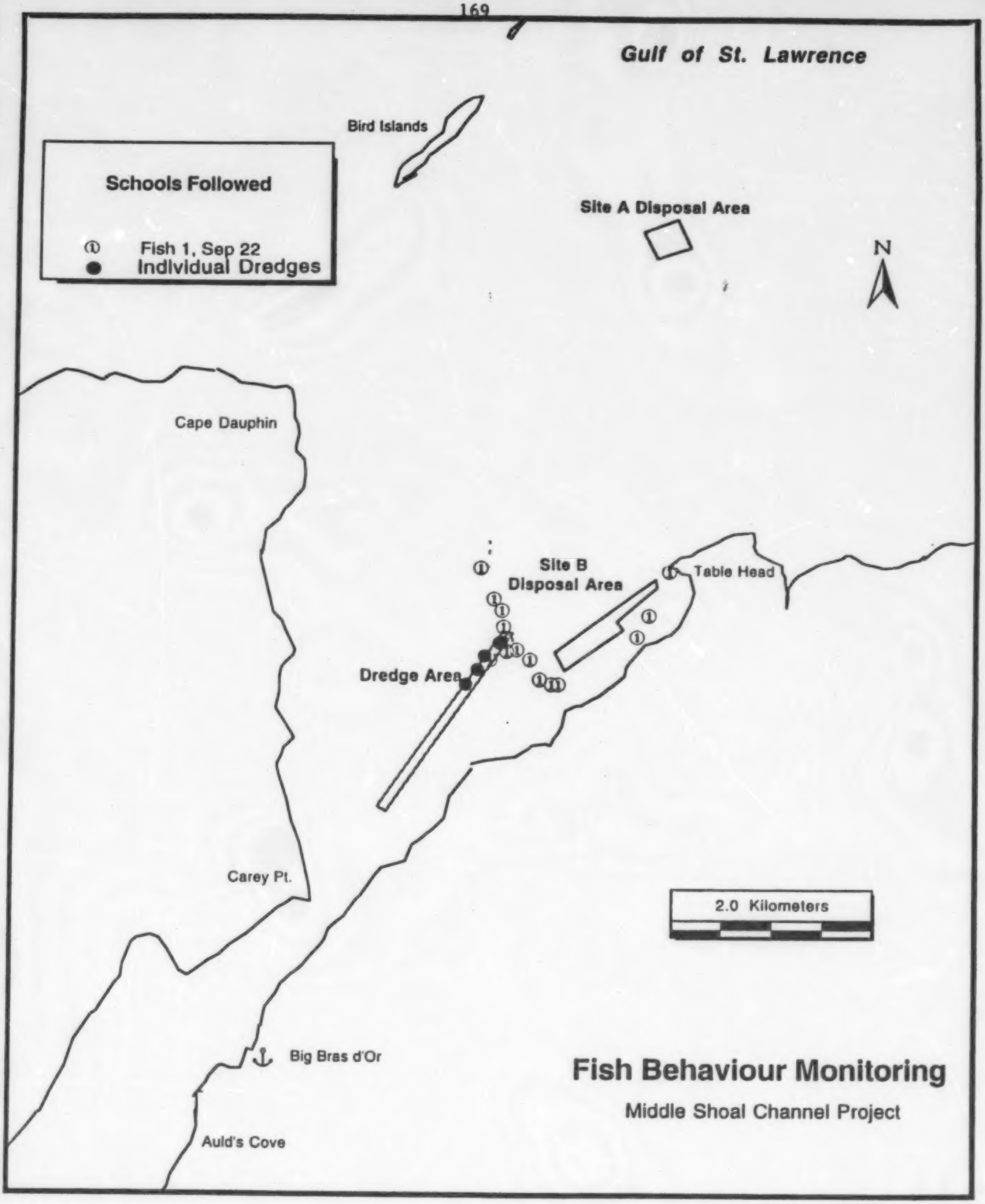
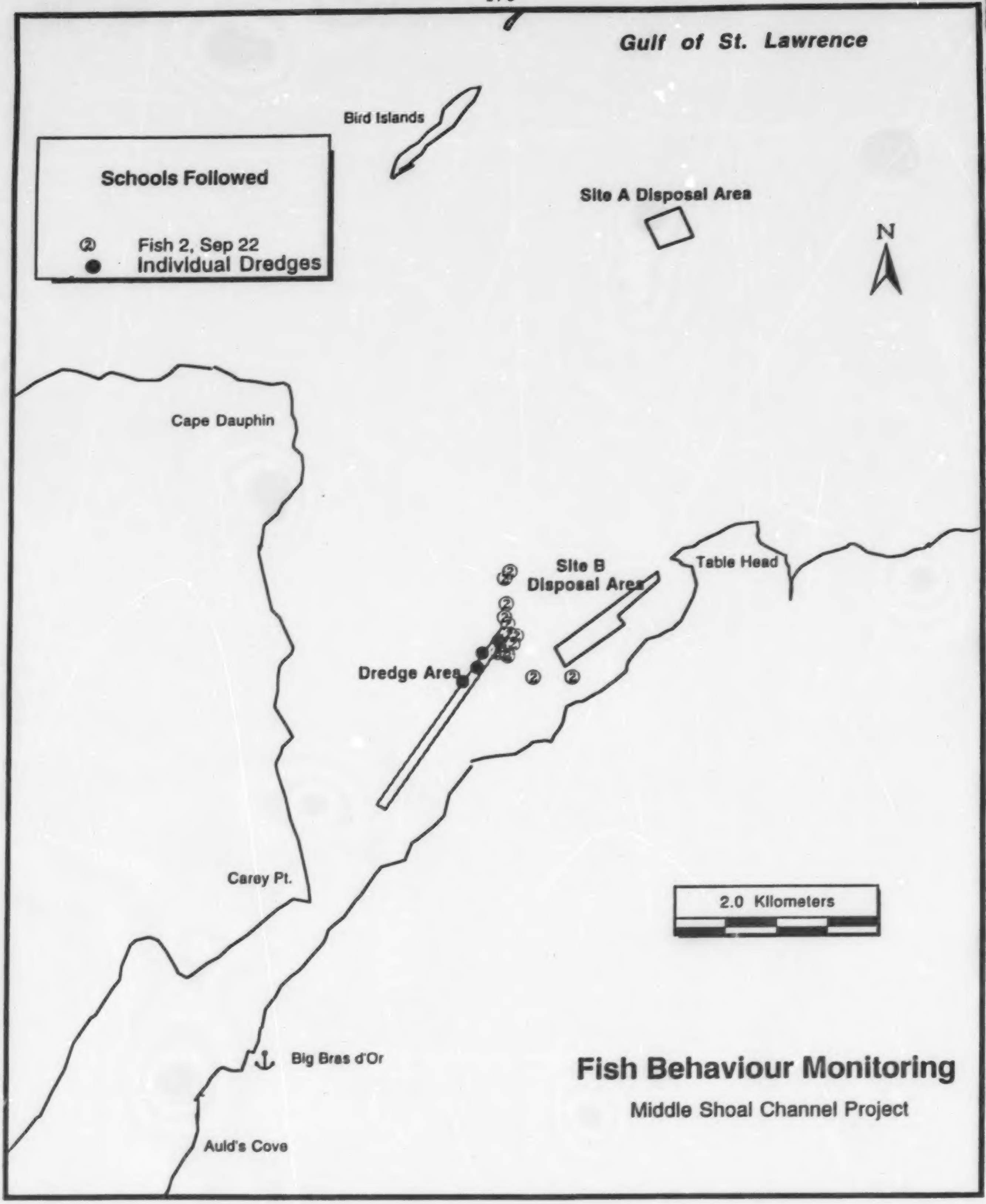
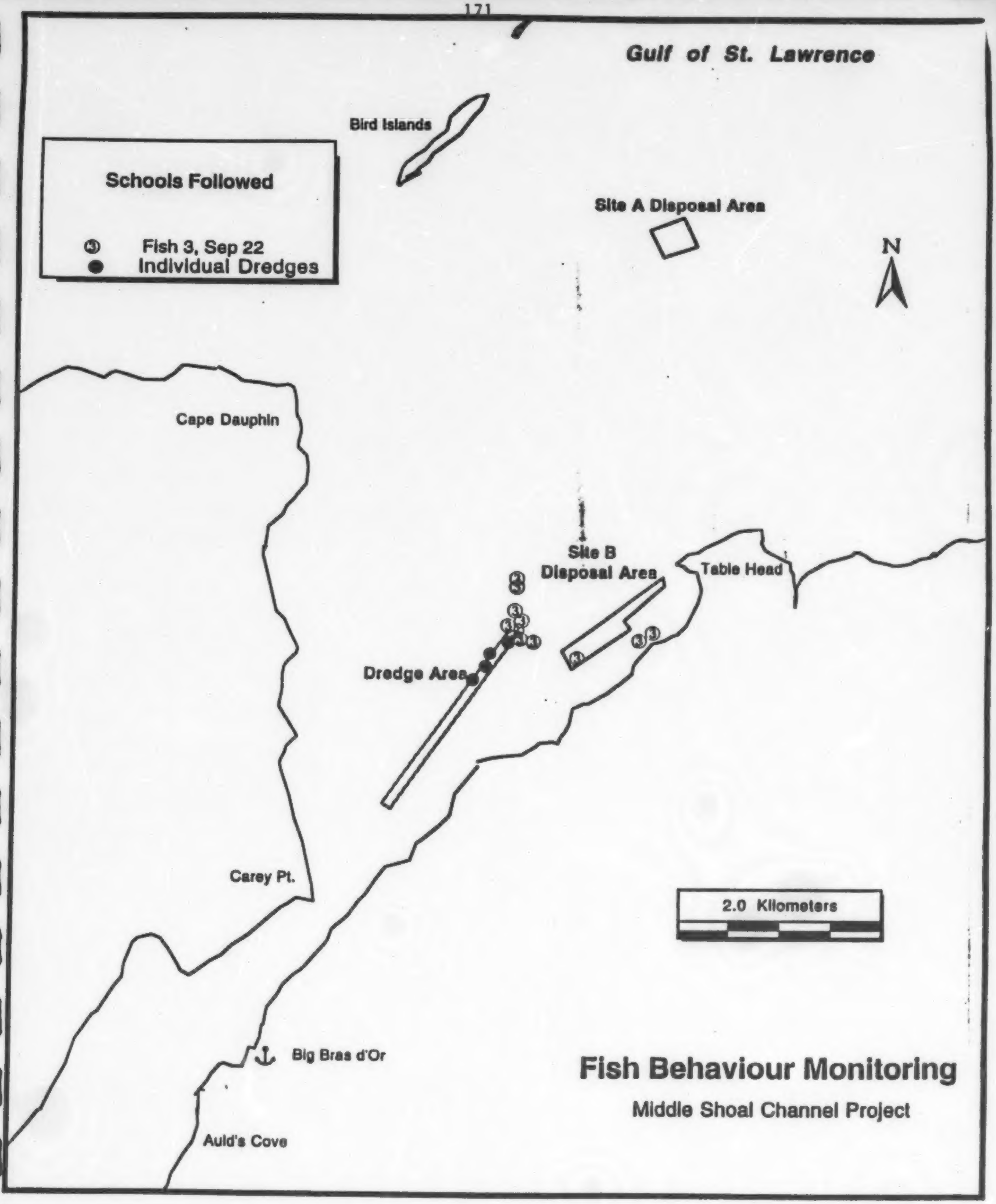
8
10
FM PF-1/1 NR-OFF


0
2
4
6
8
10
7

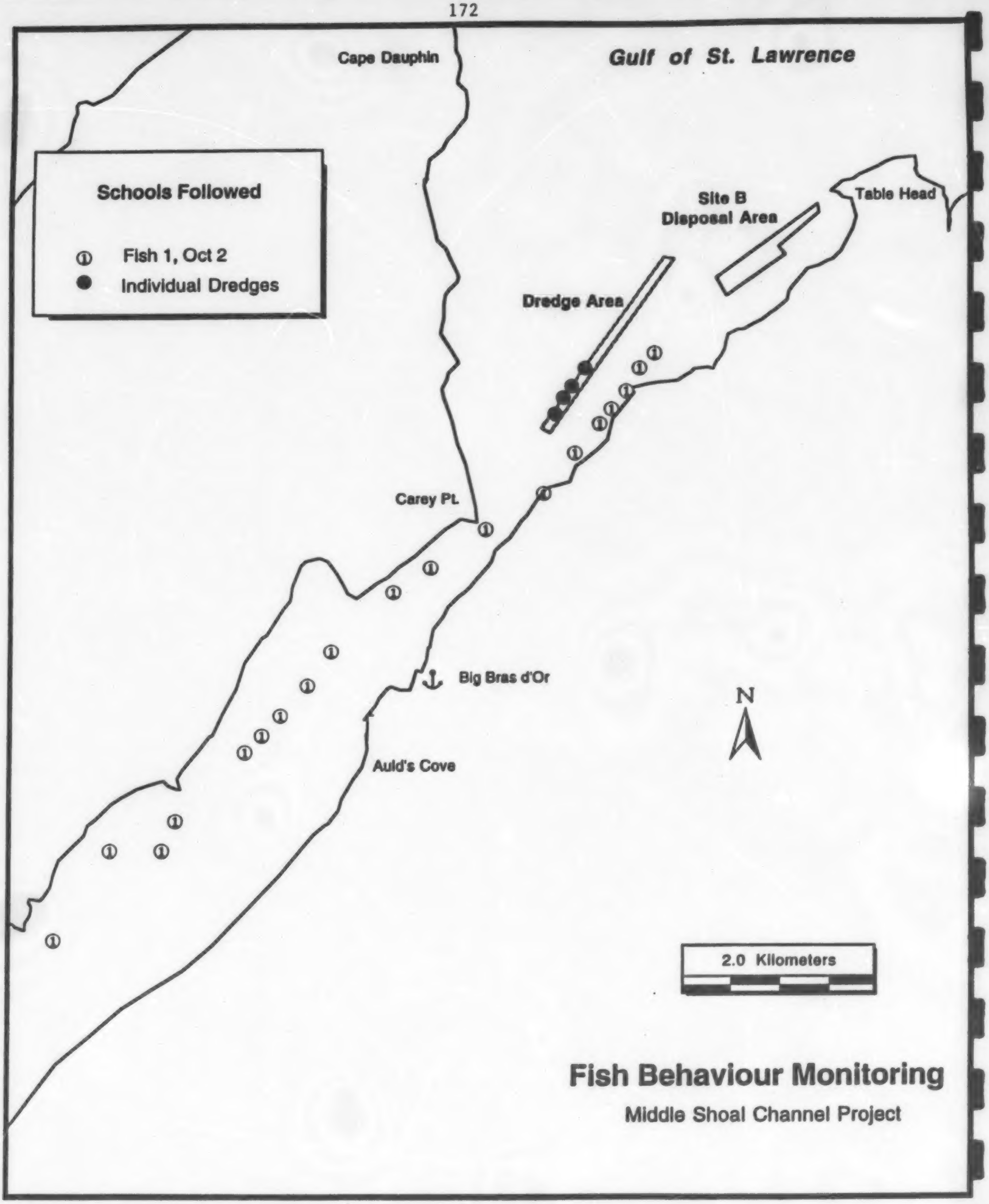

Gulf of St. Lawrence
Bird Islands
Schools Followed
① Fish 1, Sep 22
● Individual Dredges
Site A Disposal Area
N
Cape Dauphin
Site B
Disposal Area
Table Head
Dredge Area
Carey Pt.
2.0 Kilometers
Big Bras d'Or
Auld's Cove
Fish Behaviour Monitoring
Middle Shoal Channel Project


Gulf of St. Lawrence
Bird Islands
Schools Followed
② Fish 2, Sep 22
● Individual Dredges
Site A Disposal Area
N
Cape Dauphin
Site B
Disposal Area
Table Head
Dredge Area
Carey Pt.
2.0 Kilometers
Big Bras d'Or
Auld's Cove
Fish Behaviour Monitoring
Middle Shoal Channel Project


Gulf of St. Lawrence
Bird Islands
Schools Followed
③ Fish 3, Sep 22
● Individual Dredges
Site A Disposal Area
N
Cape Dauphin
Site B
Disposal Area
Table Head
Dredge Area
Carey Pt.
2.0 Kilometers
Big Bras d'Or
Auld's Cove

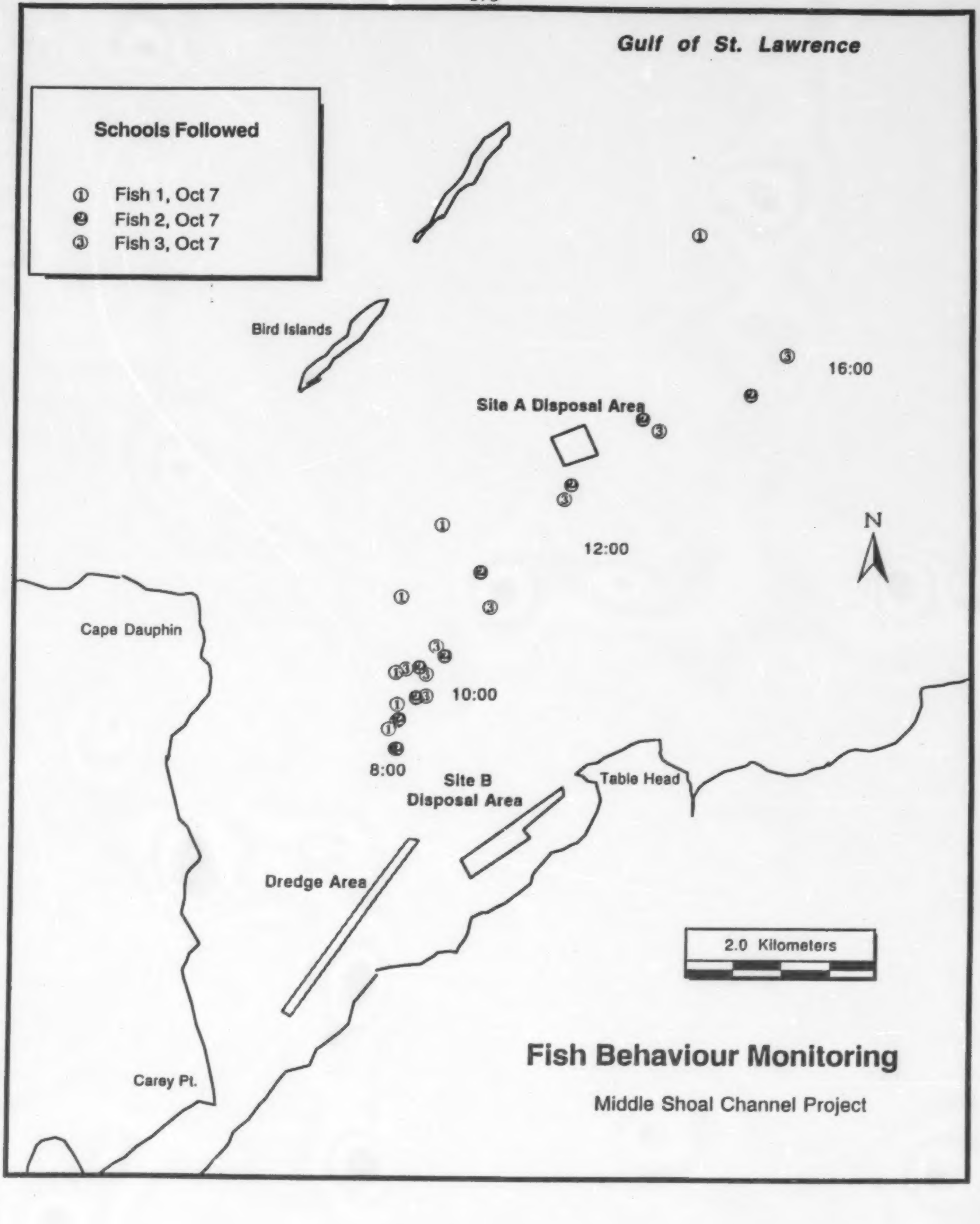
Fish Behaviour Monitoring

Middle Shoal Channel Project


Cape Dauphin
Gulf of St. Lawrence
Schools Followed
① Fish 1, Oct 2
● Individual Dredges
Site B
Disposal Area
Table Head
Dredge Area
Carey Pt.
Big Bras d'Or
Auld's Cove
N
2.0 Kilometers

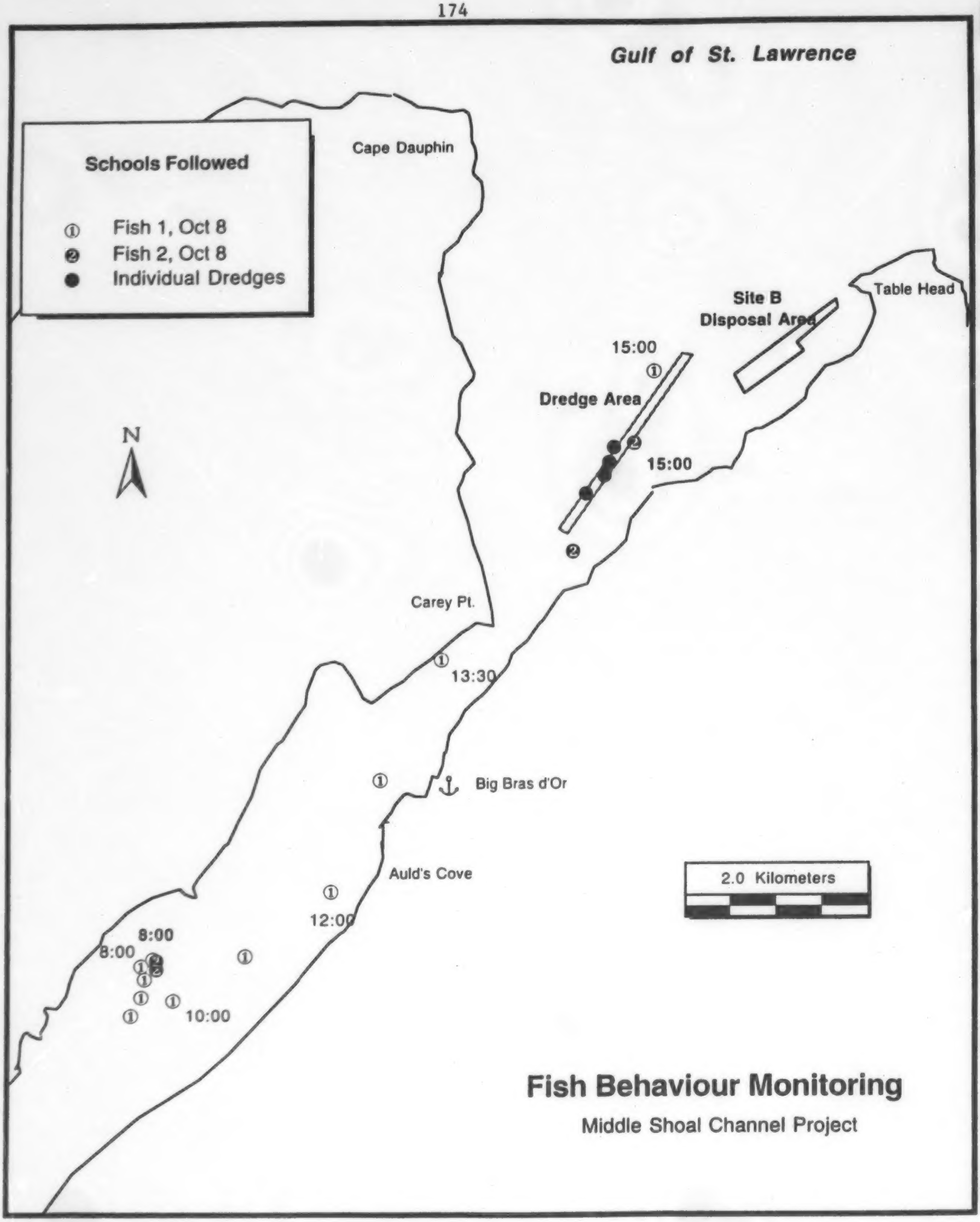
Fish Behaviour Monitoring

Middle Shoal Channel Project


Gulf of St. Lawrence
Schools Followed
① Fish 1, Oct 7
❷ Fish 2, Oct 7
③ Fish 3, Oct 7
Bird Islands
Site A Disposal Area
16:00
12:00
10:00
8:00
N
Cape Dauphin
Site B Disposal Area
Table Head
Dredge Area
2.0 Kilometers
Carey Pt.

Fish Behaviour Monitoring

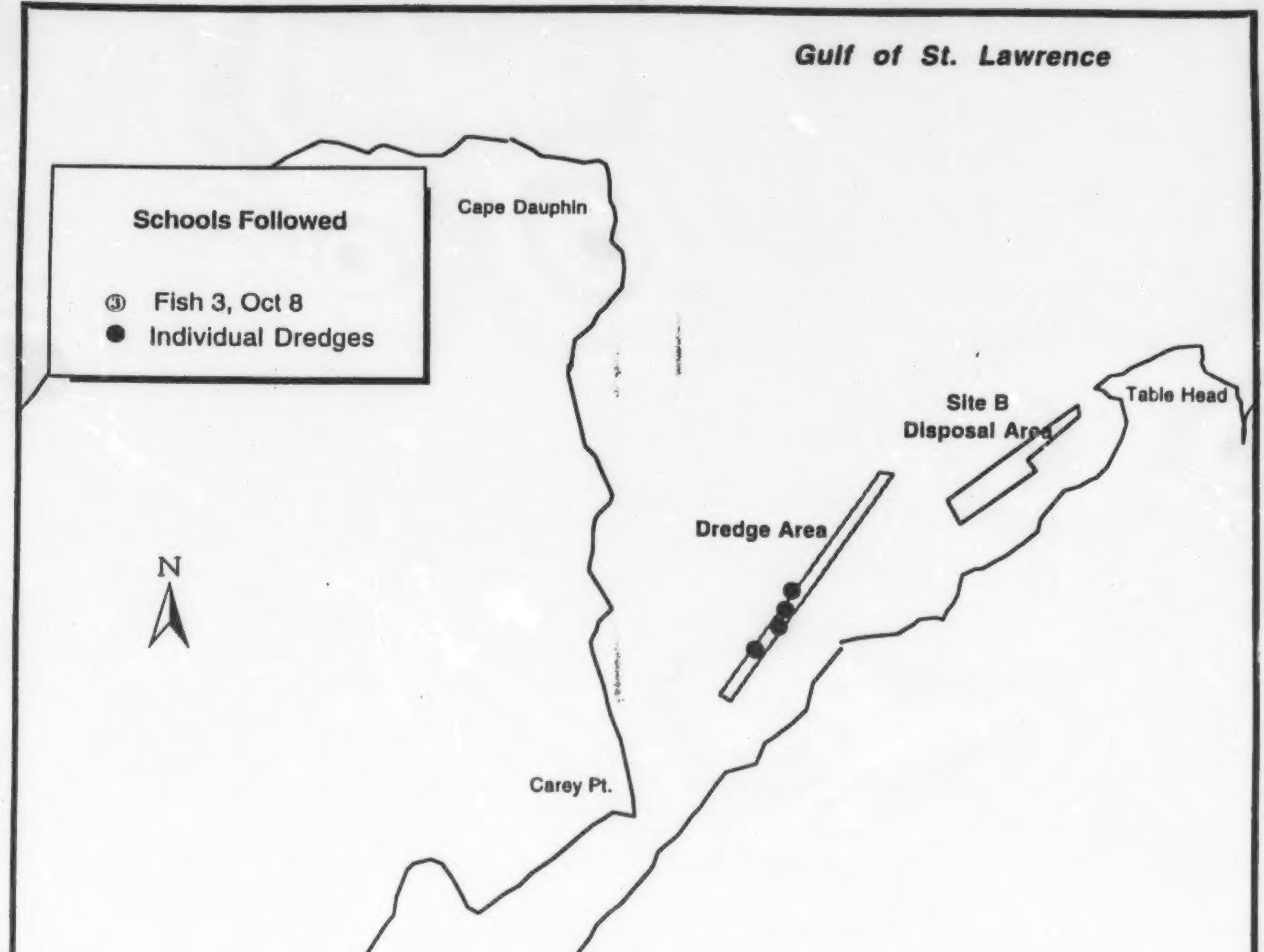
Middle Shoal Channel Project



Fish Behaviour Monitoring

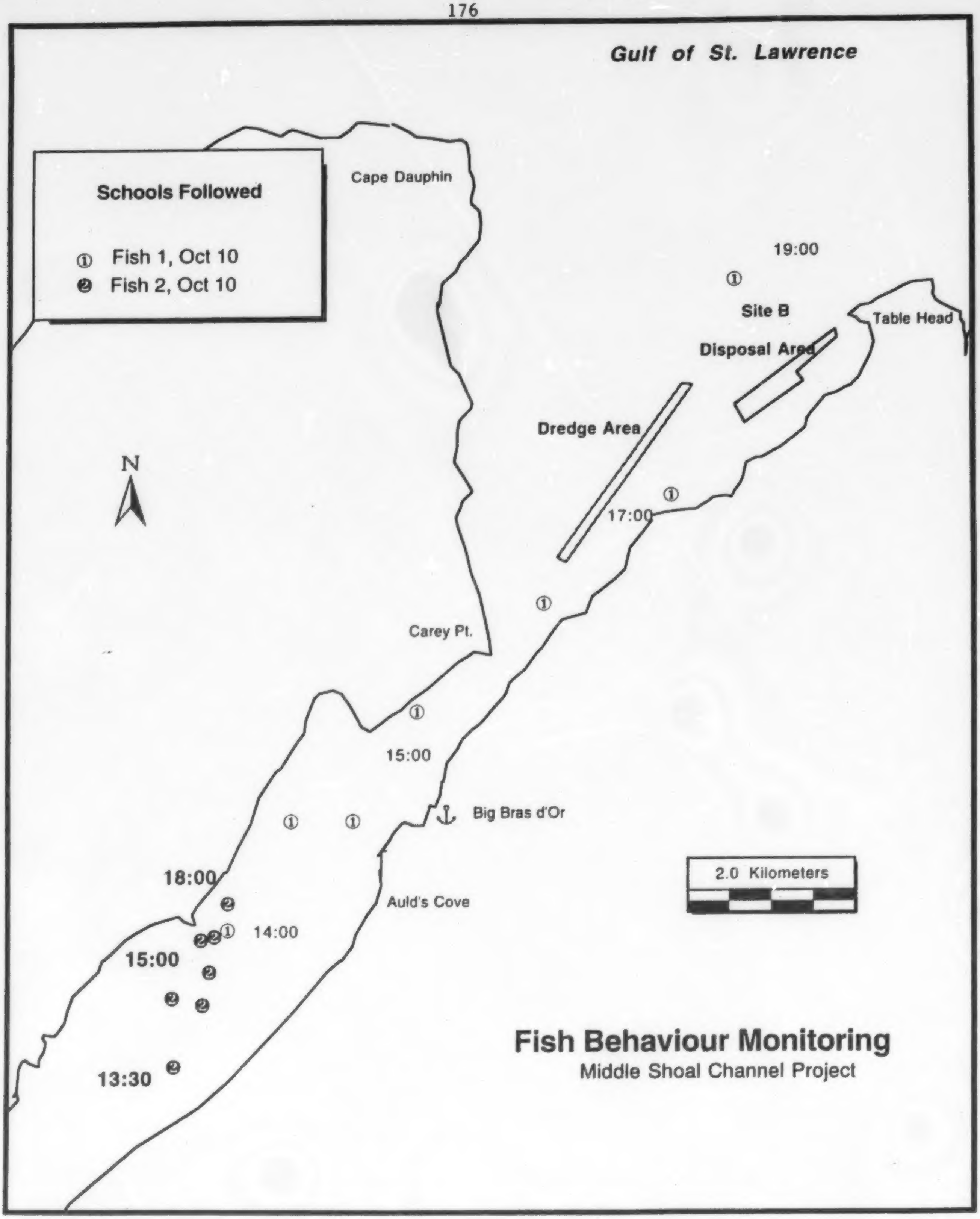
Middle Shoal Channel Project

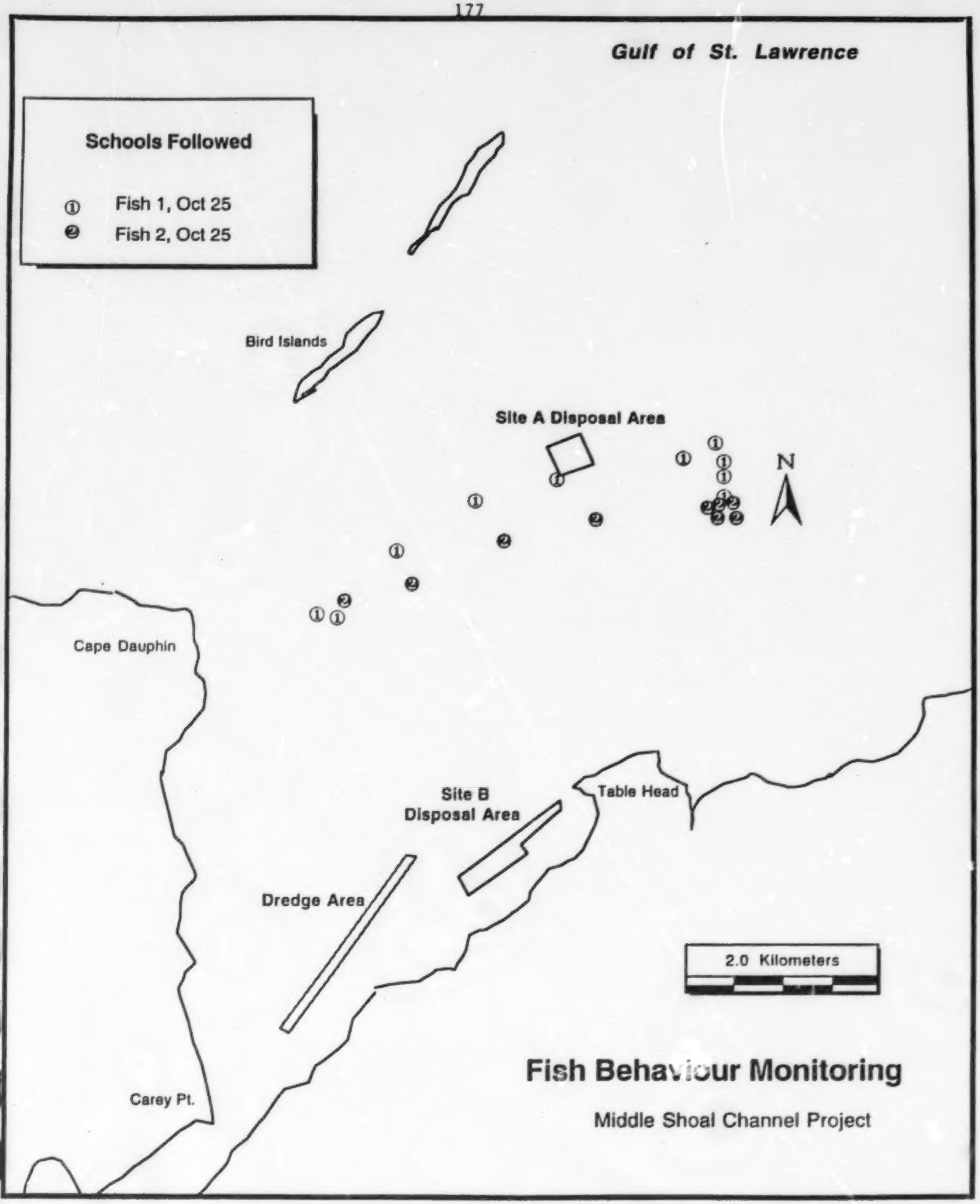
Gulf of St. Lawrence
Schools Followed
① Fish 1, Oct 8
❷ Fish 2, Oct 8
● Individual Dredges
Cape Dauphin
N
Site B
Disposal Area
Table Head
15:00
Dredge Area
15:00
Carey Pt.
13:30
Big Bras d'Or
Auld's Cove
12:00
8:00
8:00
10:00
2.0 Kilometers


Gulf of St. Lawrence
Schools Followed
③ Fish 3, Oct 8
● Individual Dredges
Cape Dauphin
Table Head
Site B
Disposal Area
Dredge Area
N
Carey Pt.
14:00
Big Bras d'Or
Auld's Cove
2.0 Kilometers
11:00
8:30

Fish Behaviour Monitoring

Middle Shoal Channel Project


Gulf of St. Lawrence
Schools Followed
① Fish 1, Oct 10
❷ Fish 2, Oct 10
Cape Dauphin
19:00
Site B
Table Head
Disposal Area
Dredge Area
N
17:00
Carey Pt.
15:00
Big Bras d'Or
18:00
2.0 Kilometers
Auld's Cove
14:00
15:00
13:30
Fish Behaviour Monitoring
Middle Shoal Channel Project


Gulf of St. Lawrence
Schools Followed
① Fish 1, Oct 25
❷ Fish 2, Oct 25
Bird Islands
Site A Disposal Area
N
Cape Dauphin
Site B Disposal Area
Table Head
Dredge Area
2.0 Kilometers
Carey Pt.
Fish Behaviour Monitoring
Middle Shoal Channel Project

Date	Time	No. of Fish Schools
17 September	20:52 (not working)	15
	00:59 (working)	32
21 September	20:40 (not working)	32
	00:11 (working)	65
22 September	20:57 (not working)	51
	00:40 (working)	52

Range (m)	No. of Schools Oct. 22	No. of Schools Oct. 23
30 - 40	27	8
60 - 80	8	3
120 -160	6	8
240 - 320	7	5

Range (m)	No. of Schools Oct. 24	No. of Schools Oct. 25
30 - 40	12	0
60 - 80	12	1
120 -160	7	3
240 - 320	17	2

Location	Average No. of Schools
Aulds Cove	14.5
New Cambellton	7.85
Channel Center	2.71

APPENDIX 9

Comments by John M. Green, Memorial University, submitted to H.B. Nicholls following attendance at the Middle Shoal Channel Project RAP Habitat Subcommittee meeting #5, held December 18, 1996 at BIO

Comments by John M. Green submitted to H.B. Nicholls, Head Environment Assessment Section following attendance at the Middle Shoal Channel Project, Regional Advisory Process, Habitat Subcommittee Meeting #5, held December 18, 1996 at BIO

The following comments on the monitoring work done in relation to the impact assessment of the Middle Shoal Dredging Project are based on information I received while attending the meeting held at the Bedford Institute of Oceanography on December 18, 1996. Prior to the meeting the only information I had seen about the project was the summary statements I received from your office on December 16. Therefore, my knowledge about specific work conducted at the site was derived entirely from the verbal reports given by the proponent and consultants at the December 18 meeting, and their responses to questions.

I have been conducting research on the behavioural ecology of fishes at Memorial University of Newfoundland since 1968, and one of my primary research interests relates to orientation and migration processes, particularly in inshore marine fishes. I was particularly interested, therefore, in hearing about the fish behaviour work done in connection with the monitoring program.

The physical oceanographic and sediment information presented by Martec provided a good description of water movement and background levels of suspended sediment at the project site. Their studies also provided data on the behaviour of the dredged materials and its residency time in the water column. While the removal and dumping of dredged materials can have severe consequences for fish, the very low levels of fines in the dredged materials, and consequently its rapid settling, suggest minimal, if any, impact on fishes at both the removal and dump sites. Based on information presented, fish in the vicinity of the channel are periodically exposed to 'natural' levels of suspended materials comparable to, or in excess of, those caused by the dredging. The low transport of dredged materials also suggests that the dredging and dumping had no, or low, impact on fish habitat other than at the dredge and dump sites. There is little doubt that fish in the area could have avoided contact with areas of high suspended material during the dredging operation.

One point not raised during Martec's presentation was whether testing was done of the dredged materials to determine if the operation released potential toxins into the water. I assume that this was either done, or that prior analysis indicated that there was no potential problem to deal with.

With respect to the biological monitoring there are several points to be made. If one refers specifically to the Statement of Issue ' Does the monitoring program .... allow us to discern the impact of the 1996 dredging operation in Middle Shoal Channel on the movement of fish in and through the channel ....' my view is that it does not. Having said this, let me add that it is probably unlikely that any monitoring program initiated when this one was could have provided this information. The point was strongly made by individuals at the meeting that you can not discern impacts unless you know how a system 'normally' works, and, in this instance, I concur. It is regrettable that data on the movement of fish through the channel was not collected prior to the start of dredging. But this would have required a major research effort spanning the season during which dredging was to take place.

On the other hand, it is possible to design studies which determine if particular species of fish exhibit avoidance responses to a dredging site or to dredging equipment. This seems to have been the approach taken by the proponent in this instance, with mackerel being the focus of the field work. This species was chosen, apparently, mainly for reasons related to its abundance and relative ease of capture.

The data obtained from the fish sounder transects seems to be of limited value. Based on the information presented (which admittedly may not tell the whole story), my assessment of what can be concluded from the data is that fish were present along each transect throughout the study. It may be that differences in the number of fish (or schools) along each transect can be statistically compared with one another, and for different time periods, but it is not clear what this might mean, and it is not easy (possible!) to directly relate these data to questions about effects of the dredging on fish migration through the channel.

The efforts made to calibrate the sounder units in each boat based on known targets is important but still leaves open the question of differences between boats. For example, it has been demonstrated in previous studies that boat noise has a significant impact on the movement of fish (e.g. herring). Since no two boats probably sound the same, it is questionable if it is appropriate to compare sounder results between different boats.

The consultant's view regarding the transect data seemed to be that they could be 'interpreted' in a particular way based on the fish tracking data. There are of course other equally plausible interpretations of the data set presented and all such interpretations simply represent hypotheses about what is actually happening. With out testing such competing hypotheses we don't, of course, know which, if any, approximates the truth.

With respect to the tracking data, a number of concerns were expressed at the meeting. The specific technique used (attaching surface floats to fish via monofilament line) is not new and was used in some of the earliest fish homing work done by Professor A. Hassler's group at the University of Wisconsin. I used similar methods in several experiments quite a few years ago on a coastal marine fish in Newfoundland. This technique has been replaced by telemetry methods that provide more reliable data from much less stressed subjects. There is no doubt that the mackerel used in these experiments would have been highly stressed, and for this reason alone the results need to be interpreted with caution. As well, the assumption that tagged fish rejoined schools did not seem to have been explicitly tested (not that this would have been easy to do) and appeared to be based more on anecdotal observations that tagged subjects swam fast at times - which was interpreted as an attempt to catch up with a school.

Perhaps when one sees the full data set, there are patterns to be discerned. But again, these patterns will represent hypotheses that would need to be tested. There appears to be little doubt that some mackerel pulling floats (trackers) made their way through the channel and passed close to or under the dredging equipment. Were these the responses of highly stressed fish escaping to more open water, or do they indicate that the movements of mackerel were not influenced by dredging activity and equipment? It is not possible to say.

It is of course easy to be critical of work that is, by necessity, presented in a condensed way; and perhaps a full reading of the results of this monitoring program would result in a more positive review. Even so, it seems doubtful that I could be convinced that the monitoring program 'allows us to discern the impact of the 1996 dredging operation in Middle Shoal Channel on the movement of fish in and through the channel'.

At the same time, based on a consideration of the information discussed at the December 18 meeting, a review of relevant literature, and experience derived from my own research, I do not believe there was a seriously negative impact on fish populations using Middle Shoal Channel during the dredging project.

John M Green

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23 December 1996